POWER

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They Took a Chance

SIXTEEN years ago a boilermaker made a boiler with an 18-inch drum running across the firebox connecting the water legs.

It was only a few inches above the floor, and the upturned flange of the ashpit made it practically impossible to get at its single-riveted lap-seam joint. There were no handholes or other openings by which its interior could be inspected.

Last April an inspector of the United States Steamboat Inspection Service subjected this boiler to a hydraulic pressure, fifty per cent in excess of that at which it was allowed to operate and went over it minutely with a testing hammer.

All except the underside of this cross pipe, which was so near the floor that a hammer could not be used upon it even if it had not been obstructed by the flange of the ashpit.

And he issued a certificate that it was safe for operation at 140 pounds.

One day the engineer of the boat noticed water trickling from the underside of the drum, and sent for a welder to come and plug the leak.

The welder could do nothing with it. It was impossible to get at it in the first place; there was too much water in the second and, whether or not it would have stopped him, he had no right to enter upon such a job unless the trouble had been reported to the supervising inspector.

And so the engineer, heedless or unknowing of the dangers of the hidden lap-seam crack, not recognizing in this leak a signal of distress from that common cause of some of the most disastrous of explosions, reasoning that if the United States authorities considered the boiler safe for 140, nothing could happen to it at 90 pounds, reduced the pressure and tried to get his crowd of excursionists home.

The metal, grooved down to less than one-third of its original thickness, just let go. The boiler did not explode, the cross-drum burst and filled the boat with scalding steam that took a toll of over fifty lives.

They took a chance, the inspector and the engineer. How many similar chances are taken every day?

F. R. Low

Balancing Power and Process Steam in Paper Mill

By H. G. INGRAHAM*

PLANT of paper mill remodeled to effect balance of power and process steam. Uniflow-engine driven generating unit operating against automatically controlled back pressure supplies the process steam and the remainder of power load is shifted automatically to condensing turbine unit. Vertical retort oil-burning furnaces feature of boiler room.

WHEN the National Paper Products Company authorized a development and modernization program for its Stockton (Calif.) Division, the power plant offered one of the largest subjects for investigation. The possible economies that could be secured by generating all electric power were apparent when considering the inevitable increase in demand for exhaust steam owing to the contemplated improvements. In addition to requiring a greater volume of this steam to accommodate increased paper-machine drying capacity, proposed substitution of exhaust for live steam formerly used for process work showed the wisdom of making radical changes in the former steam plant.

Originally, both paper machines were driven by variable-speed engines, the exhaust of which was insufficient for drying and other requirements. This necessitated the use of a great deal of live steam makeup at times, which, of course, is uneconomical in itself as well as causing extreme fluctuations in boiler loads. The former lack of heat balance would have been magnified with an increased demand for steam from the five

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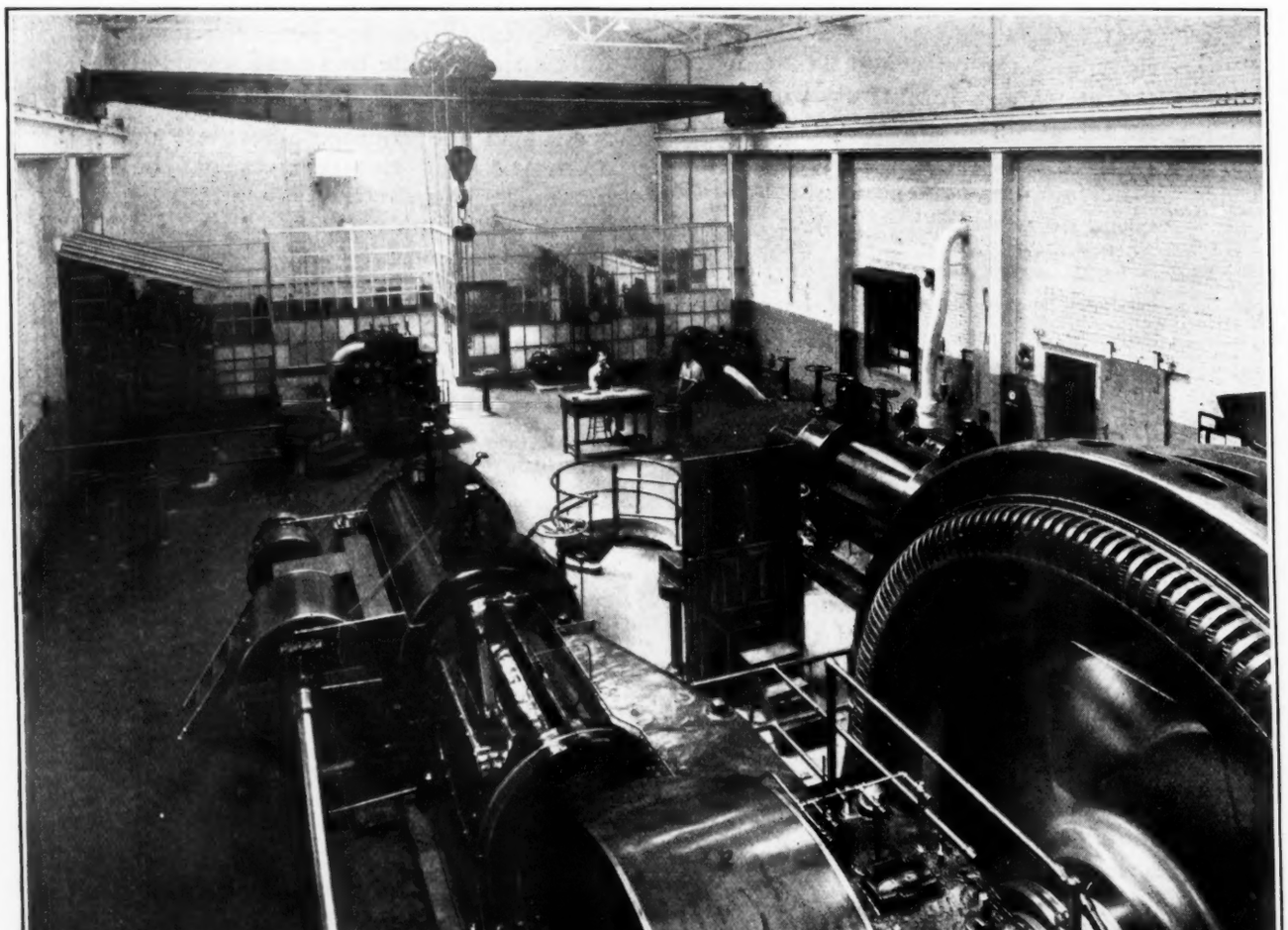


Fig. 1—Generating room of National Paper Products Co.'s plant

180-lb. pressure boilers then in use. Feed-water troubles, wastage of condensate, inefficient furnaces and settings for high ratings called for immediate expenditures, even in the event no generating equipment were installed.

A careful check of the electric power and steam consumption was made to determine sizes and types of prime movers suitable for fulfilling the conditions. The results showed that an average of 1,750 kw. per hour should be sufficient to supply the exhaust-steam demand. This was based on a water rate of 21.9 lb. of steam per kilowatt-hour at 16 lb. back pressure, as guaranteed by a certain manufacturer. The demand was figured to include the total heat required with the new-process equipment operating and at the increased paper production rate. The average hourly power demand was

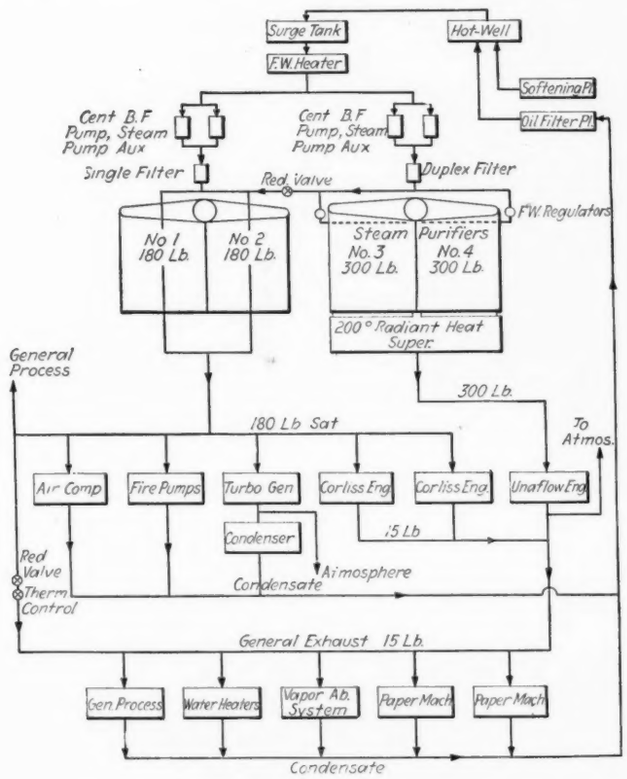


Fig. 2—Diagrammatic layout of steam and feed-water systems

estimated to be 2,400 kilowatts. The logical combination of units to meet this condition was a back pressure uniflow engine operating with steam at high pressure and superheat and exhausting at 16 lb. gage, combined with an economical condensing turbo-generator using non-superheated steam from the present boilers. These units are shown in Fig. 1.

Three of the former five boilers were removed and in their place were substituted two modern high-pressure boilers to operate at 300 lb. gage. These were equipped with superheaters so that the engine could be supplied with steam having a total temperature of 622 deg. F. All pipe and fittings were made of steel with Sargol welded joints.

The engine selected was a high-speed duplex, horizontal poppet-valve uniflow, with 28x48-in. cylinders, driving directly at 120 r.p.m., a 2,500-kva. generator. The exhaust from either cylinder can be supplied directly to either of the two paper machines at different back pressures or can be joined in a common exhaust

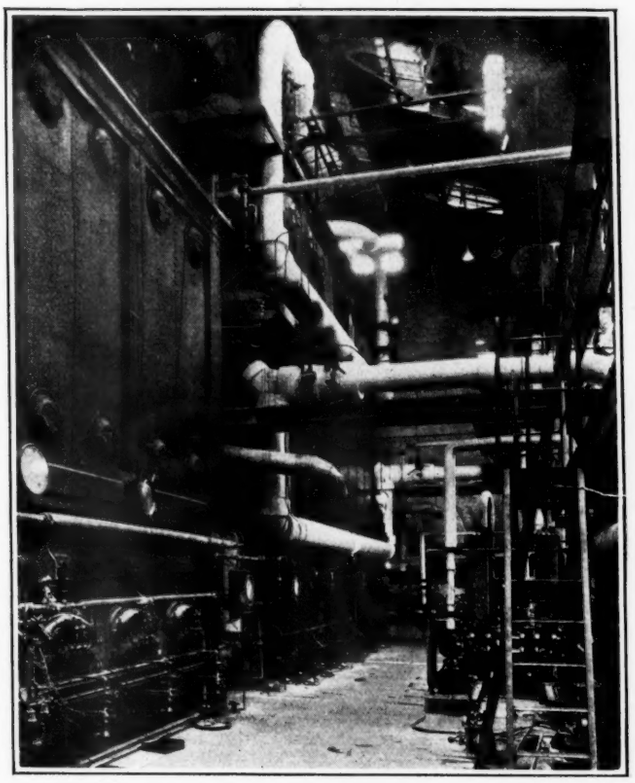


Fig. 3—View of boiler room with new boilers in background

to supply process steam other than that desired for drying paper.

The condensing turbine is of the impulse and reaction type with a direct-connected 1,250-kva. generator. To

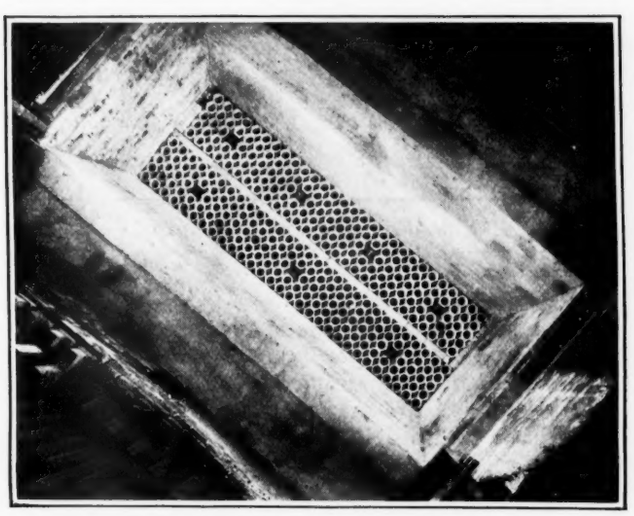


Fig. 4—Vertical retort furnace with hexagon-tile-ventilated floor and seven oil burners in place

operate the engine and turbine units in parallel, a motor-driven synchronizing device was provided on each engine cylinder. This device is under control of an ex-

haust-pressure regulator called a "pontoon," which keeps the exhaust pressure within one pound of the desired pressure. As the mill electrical load varies irrespective of the steam demands, this regulator is set to maintain such electrical load on the engine generator as is required to supply sufficient exhaust steam, the rest of the load being taken care of by the turbine. As the back pressure rises or falls, an electrical contact is formed which operates small direct-current motors on the engine valve gear and shortens or lengthens its cutoff.

kind ever installed and was designed to operate at high ratings in conjunction with an interlocking fire and damper control, Figs. 5 and 7, actuated from a one-pound variation in steam pressure. As shown in the cross-section, Fig. 6, the retort is a high, brick-lined hopper set in a framework of small channel and angle irons. Seven steam atomizing burners set in two rows in the firebox are inserted from the front and are raised into place by small rack-and-pinion lifters, so that the heads just protrude through the hexagon-tile-ventilated

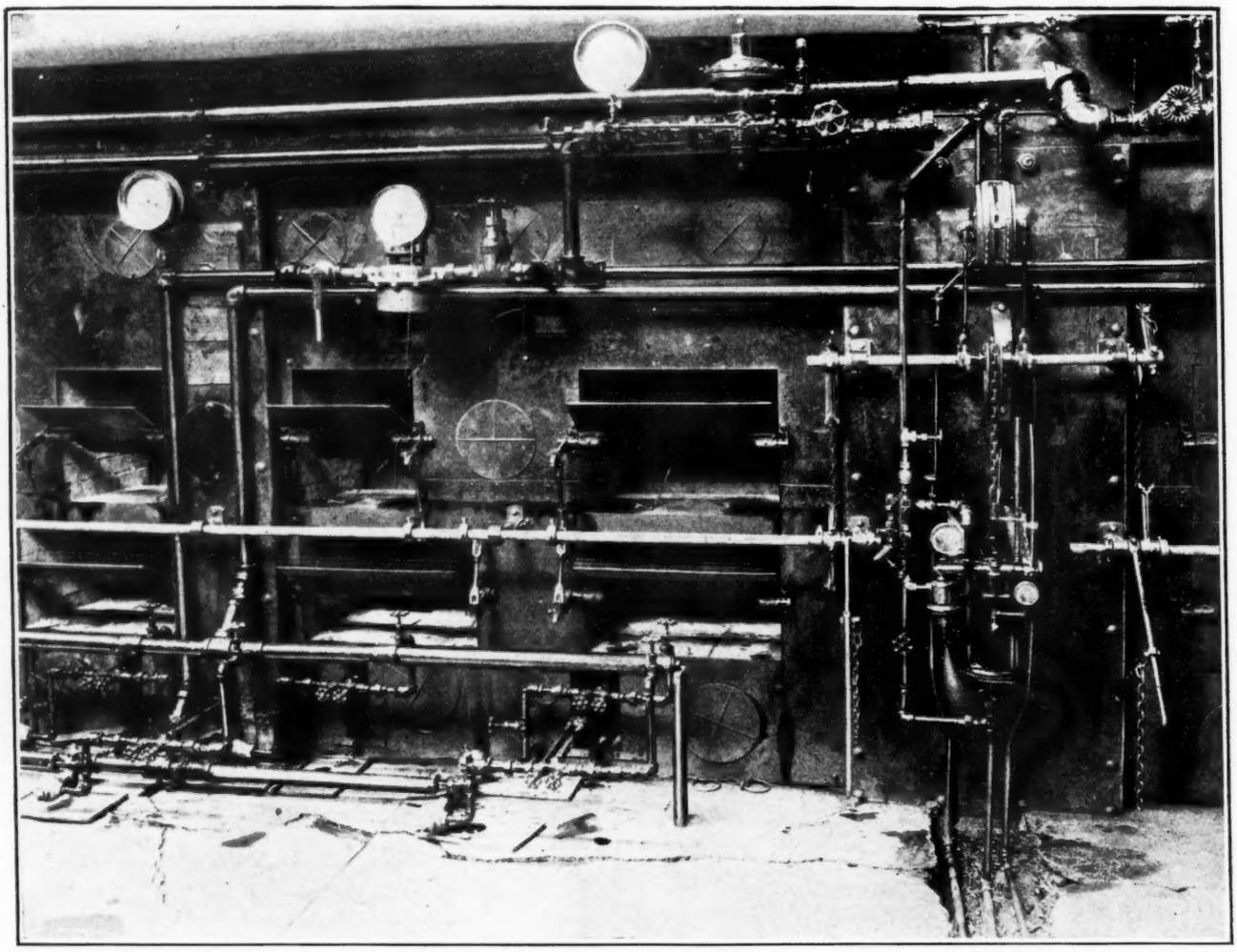


Fig. 5—Fire and damper control on new boilers. Notice movement of air doors during time exposure of photograph

The turbine governor follows the load changes quickly, while the engine governor is more static and holds a given part of the load steady while the total plant load is fluctuating. A 175-kva. geared turbine to operate at 10 lb. back pressure is used to provide Sunday and shutdown service, the exhaust steam being used to heat the feed water and to keep the paper-machine driers warm. The diagram, Fig. 2, shows the general layout.

Fig. 3 shows the two new boilers of Stirling type with high settings, each containing 7,230 sq.ft. of heating surface. These units were equipped first with five mechanical oil burners which were removed later to make way for the present vertical firing retort furnace (see Figs. 4 and 6). This furnace was the first of its

floor. Air for each burner is admitted through individual doors and ducts, the air cooling the retort but being preheated before admission to the furnace proper. Control of oil and atomizing steam is secured through needle valves, the stems of which have small rollers riding on a cam. The cam is rotated through an arc during the operation of the piston regulator. The individual burner doors are operated by toggle joints connected to a shaft, the end of which has an adjustable segment controlling the damper. This shaft is connected also to the piston regulator by chains operating over segments, so that by adjustment of the arc of travel the proper setting is obtained.

A radiant-heat superheater with one-piece forged

steel elements is placed in the front wall of each boiler, and steam is superheated to an average of 200 deg. F. Steam purifiers in the boiler drums take the place of former dry pipes with the result that the moisture content of steam supplied the superheaters is less than

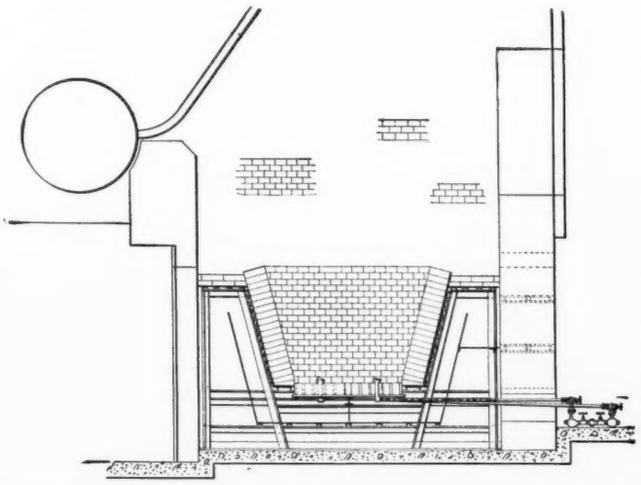


Fig. 6—Sectional elevation of vertical firing furnace

¼ per cent. Continuous surface blowdowns with a transfer to the fuel-oil heaters reclaim considerable heat formerly lost in blowing down. Accurate measurement of blow-down water is obtained by flow meters. Boiler

filter plant and into a hotwell. The treatment for filtering hot, oily condensate consists of the addition of caustic soda and alum sulphate for coagulation purposes before filtering through a graduated sand bed filter. In the hotwell treated water makeup is added by means of a float valve on the inlet from the zeolite softening plant. Temperatures in the feed-water heater are maintained around 216 to 218 deg. F. Each pair of boilers is equipped with multi-stage motor-driven centrifugal pumps on the feed lines, and horizontal steam pumps are used as auxiliaries. Twin filters are located between the pumps and feed-water regulators as an additional precaution against the possibility of oil contamination.

At times considerable fresh hot water is used for process work throughout the plant and the temperatures required are from 165 to 185 deg. F. Circulating water from the turbine condenser is passed through an instantaneous heater in the power-house basement, exhaust steam to the desired amount being admitted through a multiport valve. The surplus condensing water is reclaimed in a reservoir where it is re-used as shower water on the paper machines.

Although the power-plant work was but one step in the whole development scheme, without a redesign of the former steam plant the general process and paper-machine improvements would have lost a great portion of their present effectiveness. The remodeled power plant not only generates power more cheaply than it can be purchased from the outside, but it is in the value of the exhaust steam for process work where the sav-

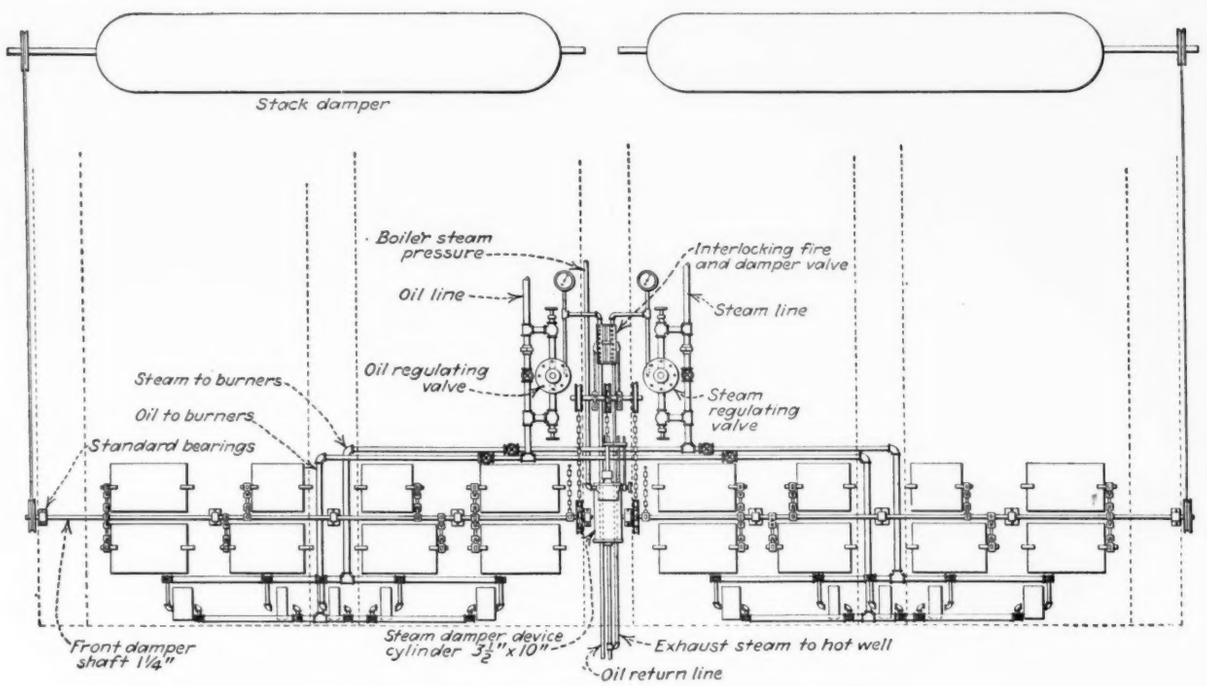


Fig. 7—Interlocking fire and damper control system

concentration is easily regulated and in this plant is kept below 250 grains per U. S. gallon expressed as chlorides.

Hot condensate from the paper machines and other sources is returned to the power plant in a common header, the returns being boosted through an oil-removal

ings are apparent. Approximately 15 per cent of the cost of steam is chargeable to the engine, the remainder being applied against paper drying and other heating.

By the installation of proper recording and indicating instruments an accurate system of daily records is obtained. There is one man whose duty is to keep these

instruments in the best possible shape. This man also keeps comparative records and supplies proper distribution costs for use of the office accountants. Periodic efficiency tests are run, also various calorimeter and pressure-drop investigations. The boiler-room crew consists of one fireman and one utility man on each of the three shifts. The average evaporation is slightly over 2,000,000 lb. of water per 24 hours.

PRINCIPAL EQUIPMENT IN POWER PLANT OF NATIONAL PAPER PRODUCTS CO.

Consulting Engineer, V. D. Simons, Chicago, Ill.

BOILERS AND SUPERHEATERS

Boilers:	
Manufacturer	Babcock & Wilcox Co.
Type	Two Stirling, Class M
Heating surface, sq.ft.	7 400
Pressure, lb. gage	180
Type	Two Stirling, Class 13-26
Heating surface, sq.ft.	7,230
Pressure, lb gage	300
Erectors	Chas. C. Moore & Co.
Superheaters:	
Manufacturer	Power Specialty Co.
Type	Foster radiant heat
Superheat at normal rating, deg. F.	200
Total steam temperature, deg. F.	622

BREECHING AND STACKS

Builders	No. 1 Union Iron Works No. 2 Pacific Coast B'ler Wks.
Erectors	No. 1 Al. Coutts No. 2 Chas. C. Moore & Co.
Type	Riveted steel
Diameter, ft.	7.5
Height above floor, ft.	165

BRICKWORK

Contractor	Bert Williams
Firebrick	A. P. Green Stockton "Gasco"
Superheater tile	M. H. Detrick Co.
Superheater insulation	Johns-Manville Co.

FURNACE AND DAMPER CONTROL

Builders	Leahy Manufacturing Co.
Type furnaces	Two vertical retort
Burners	7 steam atomizing
Type damper control	Two Leahy interlocking fire and damper
Regulators, "A-Jacks"	National Regulator Co.
Erectors	Leahy Mfg. Co.

PUMPS

Boiler Feed:	
Manufacturer	A. S. Cameron Steam Pump Wks.
Type	One 5-stage centrifugal One 4-stage centrifugal
Manufacturer	Worthington Pump & Mach. Corp.
Type	1 duplex center packed D slide valve
Manufacturer	Union Steam Pump Co.
Type	1 Burnham simplex outside packed pot valve
Fuel-Oil Pumping Set:	
Pump manufacturer	Worthington Pump and Mach. Corp.
Size, in.	6x3½x6
Type	Outside end packed
Heater manufacturer	Griscom-Russell Co.
Erector oil pumping set	Chas. C. Moore & Co.
Miscellaneous pumps	Hayton Pump & Blower Co. Byron Jackson Pump Co. Sterling Pump Co.

FEED-WATER SYSTEM

Softener:	
Type	3 unit Zeolite
Capacity, gal. per 24 hr.	185,000
Manufacturer and erector	The Permutit Co.
Oil Removal Filter:	
Type	Single filter coagulating
Capacity, gal. per hr.	10,000
Manufacturer and erector	The Permutit Co.
Feed-water heater	Stickle Open Coil
Grease extractors	1 Blackburn-Smith, twin 1 Griscom-Russell, single
Control service	Cyrus W. Rice & Co.

ENGINE GENERATING UNIT

Engine:	
Manufacturer	Nordberg Mfg. Co.
Type	Duplex horizontal poppet valve uniflow
Cylinder dimensions, in.	28x48
Speed, r.p.m.	120
Guaranteed water rate, full load, 15 lb. per kw.-hr., b. p., lb	21.3
Generator:	
Manufacturer	Allis-Chalmers Mfg. Co.
Capacity, kva.	2,500
Back-pressure regulators	Northwestern Mfg. Co.
Throttle valves	Strong-Carlisle-Hammond Co.
Multiport relief valves	Cochrane Corp.

TURBO-GENERATOR UNIT

Turbine:	
Manufacturer	Westinghouse Elec. & Mfg. Co.
Type	Condensing, impulse and reaction
Generator:	
Manufacturer	Westinghouse Elec. & Mfg. Co.
Capacity, kva.	1,250
Condenser:	
Manufacturer	Union Steam Pump Co.
Type	Surface
Size, sq.ft.	1,800
Oil cooler	Griscom-Russell Multiwhirl

ELECTRICAL EQUIPMENT

Switchboard	8 panel
Manufacturer	Westinghouse Elec. & Mfg. Co.
Cable	Standard Underground Cable Co.
Disconnect switches	Electrical Engineering Co.
Miscellaneous fittings	Western Electric Co.

MISCELLANEOUS EQUIPMENT

Traveling crane, 25-ton	Whiting Corporation
Piping, valves and fittings, Sargol welded	Crane Co.
Blowoff valves, tandem	Yarnall-Waring Co.
Automatic stop and check valves	Strong-Carlisle-Hammond Co.
Steam purifiers	Tracy Engineering Co.
Pipe covering	Johns-Manville, Inc.
Instantaneous water heater	Griscom-Russell Co.
Engine indicators	Crosby Steam Gauge & Valve Co.
Boiler meters	Bailey Meter Co.
Flow meters and CO_2 recorders	Republic Flow Meters Co.
Recording instruments	C. J. Tagliabue Mfg. Co., Foxboro Co., Bristol Co.
Steam traps	Crane Co. and W. H. Nicholson Co.
Motors	Westinghouse Elec. & Mfg. Co.
Miscellaneous valves	Edward Valve Co., Lunkenheimer Co. and Auld Co.
Oil filters	S. F. Bowser Co.

Large Turbo Compressors

The Engineer, for Sept. 4, 1925, describes an installation of large turbo air compressors serving a group of coal mines in South Wales. There are four of these machines, each having a capacity of 40,000 cu.ft. of free air per minute, compressed to a pressure of from 78 lb. to 85 lb. per sq.in. Three of them, in one plant, are driven by steam turbines operating with an initial steam pressure of 350 lb. per sq.in. and an initial temperature of 750 deg. F. These turbines are guaranteed to give a steam rate of 7.9 lb. per brake horsepower-hour. The isothermal efficiency of the turbo compressors is 50 per cent. The compressor designed employs eleven stages with three stages of intercooling. The compressor speed is approximately 3,000 revolutions per minute.

The article states that the efficiency of electrically driven high-speed reciprocating compressors was found to be practically equal to that of the turbo compressor, especially when salient-pole synchronous motors were employed to drive the machine. The advantage of the large turbo compressor is its capacity for a given floor space. The situation is entirely analogous to the relative merits of the reciprocating steam engine and the steam turbine.

An interesting feature of the Hales Bar Steam Plant of the Tennessee Electric Power Co. is the calibration of the boiler steam meters in terms of the kilowatt load carried by the boiler. Bailey boiler meters are employed and two sets of charts have been provided, a summer chart calibrated on the basis of 2 in. back pressure on the turbine and a winter chart for 1 in. back pressure. Inasmuch as this plant is a stand-by, it will usually operate on a high and nearly constant load factor which makes such a reading of the boiler meter indicate closely the electrical load.

Practical Pointers in the Art of Softening Boiler-Feed Water

By LORENZ L. BAKER
Superintendent of Power, Barnsdall Refining Co.

FOURTEEN years ago, when the writer was attempting to operate his first water softener, he knew nothing about the subject and searched for information in libraries and magazines without avail.

The writer feels that he may be criticized by his better informed brethren for the very elementary things that will be discussed, but can only say that there might have been a day in the past when they too would have been glad to have the elementary fundamentals.

This article will discuss the operation of the hot-process softener, which has an open heater placed on top of the sedimentation tank to receive the exhaust steam and the incoming raw cold water. The heated water then passes to the sedimentation tank, receiving the chemicals for treatment on its way.

With the possible exception of good filters, the chemical proportioner is the most important part of any softener equipment. As every operator knows, his raw-water flow is continually changing; hence if the flow of chemicals is not changed to correspond, the water will be over- or under-treated, which is sometimes worse than no treatment at all.

With under-treatment solids will be left in solution and passed through the filter. With over-treatment you are filling the boiler with soluble salts and excess chemicals which will cause priming, particularly just after a period of under-treatment. Under-treated water will precipitate most of its solids at approximately 310 deg. F., a temperature somewhat below that existing in the boiler. These solids, in the presence of sodium salts, are likely to cause priming; hence the proportioner should be watched with an eagle eye. The proportioner should also be carefully looked into when purchasing softening equipment.

Tests Used to Control Softening

The thing that bothered the writer most was the making of tests. This matter will now be discussed in the most elementary way possible.

The tests are made by a method that the chemist calls volumetric analysis. The first operation is to obtain a sample of the feed water (generally 100 cubic centimeters) and "titrate" it. By titration is meant the measurement of the amount of substance in solution by means of a standard solution of known strength.

The titration may be accomplished directly by adding standard solutions to the sample of water until a color change of an "indicator" shows that certain chemicals in the sample have been neutralized.

The standard solution is always confined in a tube of small cross-sections, called a burette. Burettes are long tubes of uniform bore, graduated in fractional parts of the cubic centimeter. When reading the level of a liquid in a burette, one should always read at its lowest point. This is known to the chemist as the "meniscus."

The only apparatus needed for testing boiler-feed water are three burettes, one for the acid solution, one for silver nitrate and the other for the soap solution, and a sampling flash holding a known amount, usually either 100 c.c. or 250 c.c. In addition to these a shaking bottle is needed for the hardness test.

The "indicator" already mentioned, is a telltale used in the volumetric analysis to show the point at which sufficient acid has been added to react with the constituent being determined.

The indicators used for controlling boiler-feed water are the well known "phenolphthalein" and "methyl orange." Phenolphthalein is colorless in pure water or acid solutions, but turns to a reddish-purple color in a solution of alkaline water. Methyl orange is made yellow in alkaline solution, but changes to orange, and finally to red, on the addition of the sulphuric acid.

When titrating water samples against standard acid solutions with these indicators, the point where the color of the indicator changes is known as the "end point," the quality of the indicator being determined by the sharpness and distinctness of the change produced by the addition of a drop more of the standard solution.

Standard acid solutions may be made up in various strengths. The so-called "normal" solution of sulphuric acid contains 49 grams of acid per liter of solution. This is much too strong for ordinary purposes. In power-plant work the normal acid is generally diluted to one-tenth or one-twentieth this strength. Thus a tenth-normal solution contains 4.9 grams of acid per liter and a twentieth-normal solution 2.45 grams of acid per liter.

Meaning of "Causticity," "Alkalinity" and "Hardness"

The terms "causticity," "alkalinity" and "hardness" so frequently used in connection with water softening are likely to cause confusion at first. "Causticity," as used in water treatment, indicates the presence of an excess of lime or caustic soda added during treatment, though such presence also would indicate alkalinity. The term is arbitrarily used to apply to those hydroxides whose presence is indicated by phenolphthalein and methyl orange. More will be said of this when the making of the test is discussed.

"Alkalinity" is the term applied to the power of neutralizing acid. Since hydroxides will neutralize acids, they not only cause the causticity, but make up part of the alkalinity.

"Hardness," which is the most widely known evidence of the presence of scale-forming solids, is that quality the variation of which makes it more difficult to obtain a lather or suds from soap in one water than another. This characteristic is made use of in the soap test for hardness to be described later.

Temporarily hard waters are those containing bicarbonates of lime and magnesium, which are partly precipitated by raising to 212 deg. F., after which they become soft and like chalk and can be largely washed out of boilers with a hose.

Permanently hard waters are those containing mainly sulphates and chlorides of calcium and magnesium. These are precipitated only at the high temperatures found in the boiler itself, namely, 300 deg. F. or more. The scale of hardness is an arbitrary one based on the number of grains of solids per gallon, and waters are sometimes classed on such a basis as follows: 1 to 10 grains per gal., soft water; 10 to 20 grains, moderately hard; above 20 grains, very hard. This classification, however, is not strictly correct. While eight-grain water may be considered as "soft" for some purposes, it would in all probability give much trouble in a boiler operating at 200 per cent of rating.

Measuring Causticity

To determine the causticity (or what is sometimes called the "Ph" alkalinity, this term being used since phenolphthalein is the indicator used for this test) one obtains a 100-c.c. sample of treated water if twentieth normal acid is used. To this add two or three drops of the colorless phenolphthalein indicator (this will be called "Ph" hereafter). If the water has been properly treated, it will be alkaline, and the indicator will turn the water a reddish purple. Fill the acid burette to zero mark and add the acid solution a few drops at a time from the burette until the last drop of acid changes the water back colorless.

This is the end point and the burette should be read. If one c.c. of the standard acid is used up, we may mark down "Ph—1.0." Two or three drops of methyl orange (hereafter to be called "M.O.") are now added to this sample. This will color the water a faint yellow. Continue adding the acid solution, a few drops at a time. Finally, the water will change to an orange color. Further drops added may change the solution temporarily to red. The correct end point is when it changes from a light yellow to a permanent orange taking care not to run to red color. If the burette now reads 2.2 c.c., record "M.O.—2.2."

At first it will be difficult to avoid the tedious process of adding a large amount of solution, drop by drop, without running into the danger of overreaching the end point. With a little experience the approach of the completion of the reaction may be noted by various signs. At first the substance being titrated is largely in excess, and therefore the standard solution from the burette is neutralized the moment it enters the liquid in the vessel below. As the end of the reaction approaches, the local color surrounding the drop as it falls into the liquid disappears more and more slowly, and flashes of the new color are seen momentarily through the whole solution when it is stirred or shaken. Only experience and practice enable one to hit the end point without much tedious drop-by-drop addition of the standard solution toward the completion of the reaction.

In making the test for hardness, one has a second burette which contains the soap solution. This is generally so standardized that one c.c. is equivalent to one grain per gallon of solids (reduced to the equivalent amount of calcium carbonate) in the water when a sample of 100 c.c. is taken.

In making this test, one c.c. is generally subtracted from the burette reading, as it requires about that much soap solution to lather 100 c.c. of pure distilled water.

To determine the hardness of the treated water, fill the soap burette with soap solution to the zero mark, obtaining a 100 c.c. sample of the water. The soap solution is added in small quantities (not over three-tenths of a c.c. at a time) to the contents of the bottle. After each addition the bottle is shaken vigorously in an up and down direction. In some waters, high in magnesium salts, a false foam appears after the addition of one or two c.c. of soap solution. At first this looks like a true lather, but disappears on standing one or two minutes. This is known as the magnesium end point and should be watched very carefully. Continue this process until a thick foam, $\frac{1}{2}$ in. high, is obtained, which will remain upon the water with practically no subsidence for a period of five minutes. The number of cubic centimeters of soap solution used to obtain this foam is the hardness of the water (expressed as calcium carbonate) after subtracting one c.c. as has been discussed.

For instance, if the burette shows three c.c. of soap used to obtain the foam, one would say the hardness was two grains per gallon. That is, the treatment has left two grains per gallon of scale-forming solids in the water, which, by the way, is very good performance.

The results of these tests are used to control the chemical treatment of the water. Due to the characteristics of the indicator used, the "Ph" test should generally be about one-half the "M.O." if the chemicals are being fed in the right proportions. Typical values for Ph in good operation may range from 0.8 to 1.2. Corresponding values of M.O. are about 2.3 $\times$ Ph.

For the conditions existing at any given plant there will be certain values of Ph and M.O. corresponding to the best operating results. Variations from these values will call for corresponding adjustments of the treatment.

If it were practicable to do so in a few paragraphs, the writer would give simple instructions for adjusting the treatment according to the test readings. However, there are so many possible combinations and so many factors likely to affect the result, that the only sensible course is to lean on the manufacturer of the equipment for operating instructions covering this point.

While it is possible to get the hardness near zero, it is the experience of the author that this is wholly unnecessary, as the chemicals will be in great excess and the extra cost out of all proportion to the good done. Two-grain hard water is all that is required, and as this can be accomplished in a hot-water plant properly operated on an excess soda charge of from one to two grains per gallon with no excess lime, it would seem that this is the only sound operating basis.

It is well to watch the alkalinity of your boiler water. This is done by obtaining samples from the water column blow-down and titrating for alkalinity, using both indicators if one wishes, but the Ph indicator need not be used since the M.O. will show that we want to know. On account of the concentrated state of the boiler water, a sample of 100 c.c. is too large; that is, it requires the use of too much of the standard acid. Hence, some fractional part of the 100 c.c. is used and a correction factor applied. For example, 25 c.c. is generally used, and the results multiplied by 4.

If 25 c.c. were titrated with M.O. to orange end point, and 5 c.c. of standard acid was used, this would be equivalent to using 20 c.c. of acid for a 100-c.c. sample. Hence, since each cubic centimeter of standard acid required to neutralize a 100-c.c. sample is equivalent to approximately $1\frac{1}{2}$ grains per gallon, the alkalinity would be 30 grains per gallon, which is a nice operating point.

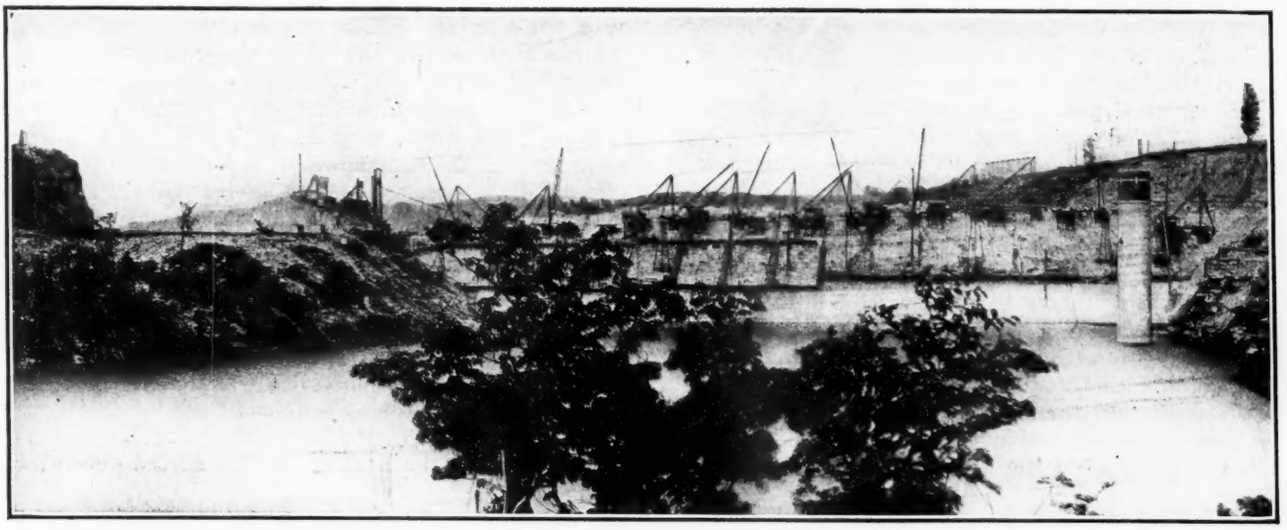


Fig. 1—Dam with 151 ft. of water in forebay. Spillway at left and intake tower at right

Dix River Hydro-Electric Plant

INSTALLED capacity of 33,000 horsepower in three units with an estimated annual output of eighty million kilowatt-hours. The effective head ranges from 165 to 235 feet and the speed is 300 r.p.m. Features are highest rock-filled dam in the world, intake tower and pressure tunnel driven in the rock connecting the tower with the penstocks.

IN THE central part of Kentucky, about 25 miles south of Lexington, the new Dix River development of the Kentucky Hydro-Electric Co. is nearing completion. This station, with an installed capacity of 28,200 kva. at 80 per cent power factor, in three units, is an important connecting link in the rapidly growing system of the Middle West Utilities Company. Lines are now in service from the coal fields of Virginia and eastern Kentucky, through central Kentucky and northwestward to Louisville, where interconnection is made with lines of other subsidiaries, extending northward into Indiana and Illinois.

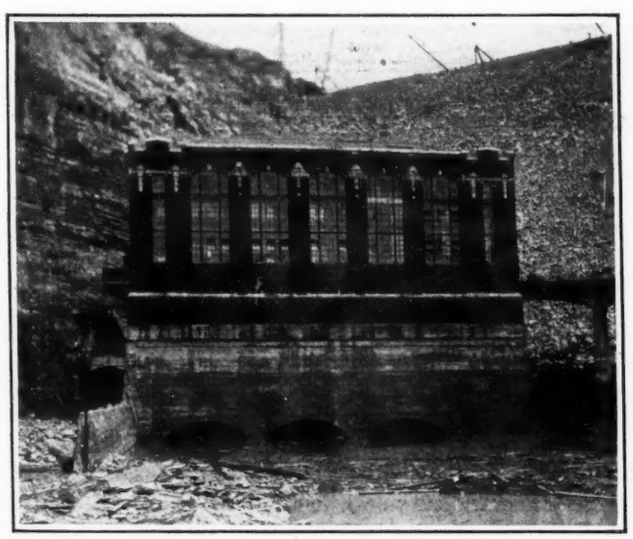


Fig. 2—Power-house substructure provides for a 40-ft. rise in the tail water

In a narrow gorge of the Dix River, about three miles above the point where it discharges into the Kentucky River, is the site of the new plant, which will be operated in conjunction with four steam stations, two in Kentucky and two in Virginia, with the load dispatching for the entire system handled from the Dix Dam Station.

Features of the development are a rock-filled dam that is believed to be the highest of its kind in the world, an intake tower near the upstream toe of the dam and a concrete-lined pressure tunnel driven in the rock around the end of the dam and connecting the tower with the penstocks.

The dam is of rock-filled type with its crest 275 ft. above the limestone foundation. On the upstream face there is a concrete slab, 18 in. thick at the bottom and 8 in. at the top, provided with expansion joints 48 ft. apart horizontally and 70 ft. up the slope. As a further insurance against tightness the wood forms for the lower 160 ft. of the dam were left in place. It is the intention to arrange the operating program so as not to draw the water below this level.

One of the unique features of the development is the entrance to the tunnel leading from the storage reservoir to the penstocks (see Fig. 3). In order to construct the dam, the river had to be diverted around the site through a tunnel. This tunnel had a double purpose —first for river diversions during the period of building the dam and then as a pressure tunnel to connect the storage reservoir with the penstocks. To provide control of the water to the tunnel for power purposes, the concrete lining was extended upstream beyond the face of the cliff sufficiently to provide a foundation for a concrete intake tower and the placing of a sealing plug in the end of the tunnel above the intake tower,

at the left Fig. 3. The tower is circular in section and is 22 ft. inside diameter down to the valve, where it is reduced to 17 ft. This tower can be seen in front of the right-hand-end of the dam in Fig. 1.

The original plan was to close the diversion tunnel during a period of low water by building in a 6-ft. pipe with valves at the upper end for closing off the water at the desired time. This plan had to be abandoned last summer when it became evident that the construction of the dam would not have progressed far enough to allow the tunnel to be closed before the winter floods. This made it necessary to provide some means of closing the tunnel during high water if the reservoir was to be filled by the time the power house was finished. To meet this condition a hemispherical bulkhead 26 ft. in diameter that would close the full cross-section of the tunnel was designed and built. This flood gate consisted of a cast-steel rim to which was riveted a plate-steel hemisphere, the gate being hinged at its upper edge over the tunnel intake. The gate was held open, as indicated by the dotted lines in Fig. 3, and lowered by means of hoist ropes at the desired time. After the dam was completed, the plug valve in the tower was closed and a concrete plug was put into the tunnel behind the hemispherical bulkhead, as indicated in the figure.

The valve at the bottom of the tower consists of a steel shell 17 ft. in. diameter by 30 ft. long, filled with concrete and weighing 575 tons. This plug is supported on the end of a ⅞-in. steel tube 4 ft. in diameter extending to the top of the tower, where it engages an oil-pressure hoist. The stem extends all the way through the plug and serves both as manhole and air vent to the tunnel.

From a drainage area of 412 square miles the Dix River has an average yearly flow of about 550 sec.-ft., this flow varying from almost zero in the summer to a maximum flood on record of about 28,000 sec.-ft. The reservoir formed by the dam has a maximum depth of 240 ft., a length of about 33 miles and an area approximating 2,940 acres.

By observance of a definite operating program, it will be possible to manipulate the reservoir so as to use practically the entire flow of the river, with a turbine capacity of 1,450 sec.-ft. For this regulation the depth of drawdown required will be about 70 ft., so that the effective head would vary from 165 to 235 ft. The intake gate at the dam, however, is low enough to allow a deeper drawdown, and it is estimated that the average annual energy output will be in the neighborhood of 80,000,000 kilowatt-hours, with a minimum 24-hour rate of 5,000 kilowatts.

For the power house a substructure of unusual height was required to provide for a 40-ft. rise in tail-water level, but as indicated in the sectional elevation, Fig. 5, a large portion of the substructure is used for housing the busbars, the switching equipment and miscellaneous auxiliaries. The drawing shows that the main operating floor is at the level of the top of the generator

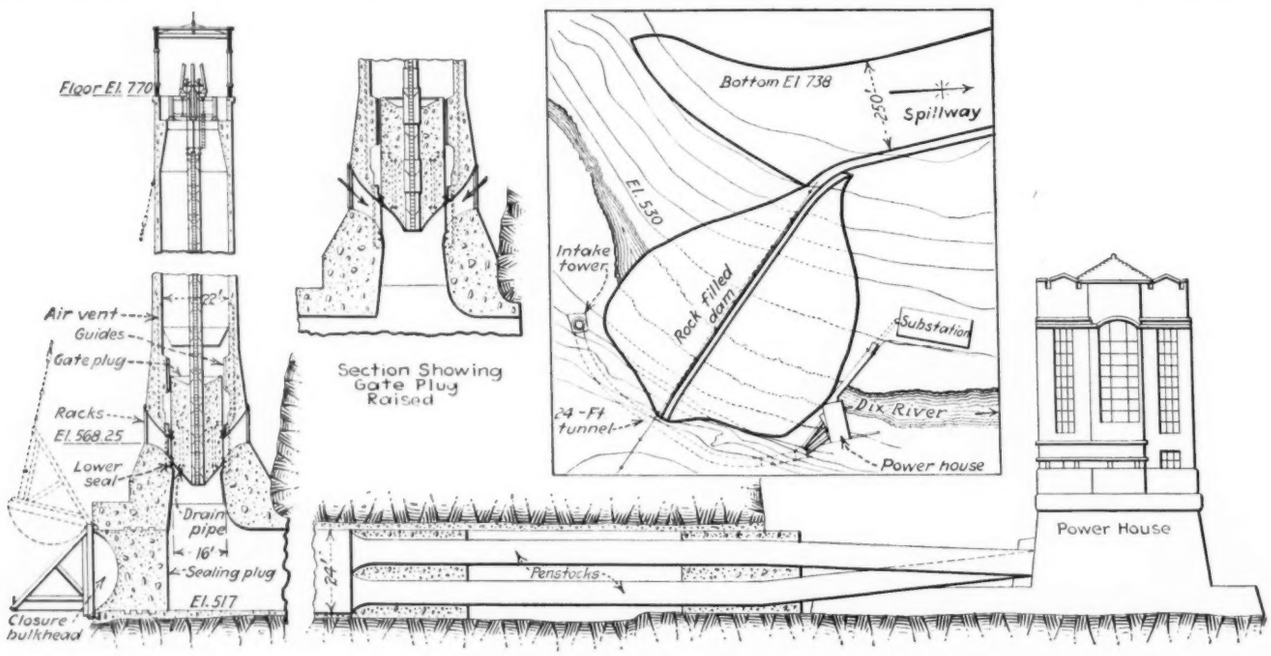


Fig. 3—Section through intake tower on the left; plan of the project right center; penstocks and power house bottom right

stator frames, only the exciter and upper bearing brackets of the generator being visible above the floor line.

To improve appearances and in order that a full view might be had of the exterior of the generator an annular space, 9 in. wide, has been left between the outside of the stator and the floor. This is covered with heavy glass plates, and flood lights are installed beneath the floor to illuminate the stator frame (See Figs. 4 and 5). In addition, glass portholes have been placed in the cover plates between the spider arms of the generator, to permit a view past the rotor into an illuminated wheelpit.

Owing to the warm climate and the location of the power house at the bottom of a narrow, deep gorge, where natural circulation of the air will be poor, it was considered desirable to pass the generator cooling air through a ventilating sash in the side wall beneath the main floor of the power house, as indicated in Fig. 5. In winter this warm air may be used for heating the operating room by closing the ventilators and opening registers in the floor.

The three turbines, furnished by William Cramp & Sons, are rated at 11,000 hp. each when operating at a head of 235 ft. and at a speed of 300 r.p.m. The spiral casing, runner and guide vanes are of cast steel, and the guide bearings are of lignum vitæ. Labyrinth seal rings were used with provisions for the installation of rubber seal rings in the future, if desired.

To improve the power factor of the system, operation of the generators as synchronous condensers is contemplated, and as under such circumstances the turbine casing will be dry, an auxiliary water supply is provided for the lubrication of the lignum vitæ bearing and runner seals.

The three Woodward actuators, with squirrel-cage induction-motor driven flyballs, are grouped in front of the switchboard on the main floor. This grouping of the governor actuators at a central point is somewhat unusual, but was made possible by the use of the motor-driven flyballs. The centralized location offers considerable advantage from the point of convenience of operation.

Three-phase 60-cycle 13,200-volt current is generated by three Allis-Chalmers generators, each having a capacity of 9,400 kva. These machines are equipped with directly connected 80-kw. 250-volt exciters. Kingsbury thrust bearings are used, with a capacity of 175,000 pounds.

Three penstocks of 8-ft. diameter at the upper end and having an average length of 230 ft., are sealed into the 24-ft. horseshoe-shaped tunnel by means of a concrete plug. The maximum water velocity at full load is 8.6 ft. per sec., and the corresponding estimated loss of head is 0.7 ft. Although the maximum static head on the penstocks is 220 ft., they are designed for

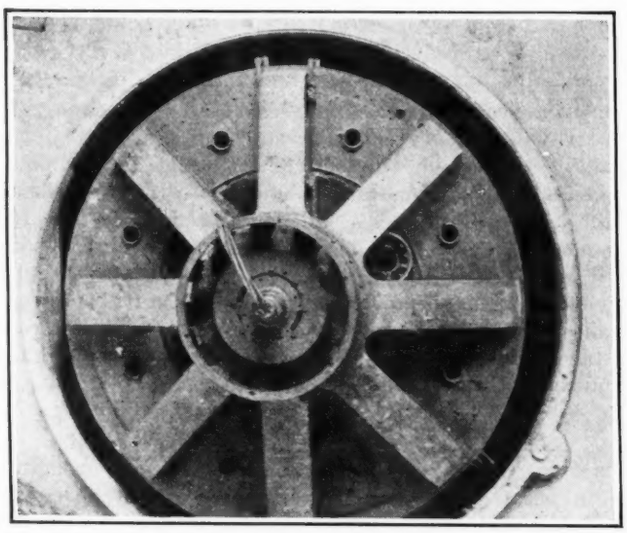


Fig. 4—Top view of one generator showing the 9-in. annular space around the stator, which is to be covered with heavy glass

a head of 300 ft. to allow for water hammer. Midway between the power house and the tunnel a sliding expansion joint is provided in each penstock.

At the power-house end each penstock enlarges to a diameter of 10 ft. to form the plate-steel casing of a Johnson valve having a discharge diameter of 66 in. To facilitate the removal of valve parts, a short piece of cast-steel pipe is inserted between the valve and the turbine casing. Provision has been made for the removal of these parts within the power house by providing removable slabs in the main and the next lower floors immediately over the valves, through which

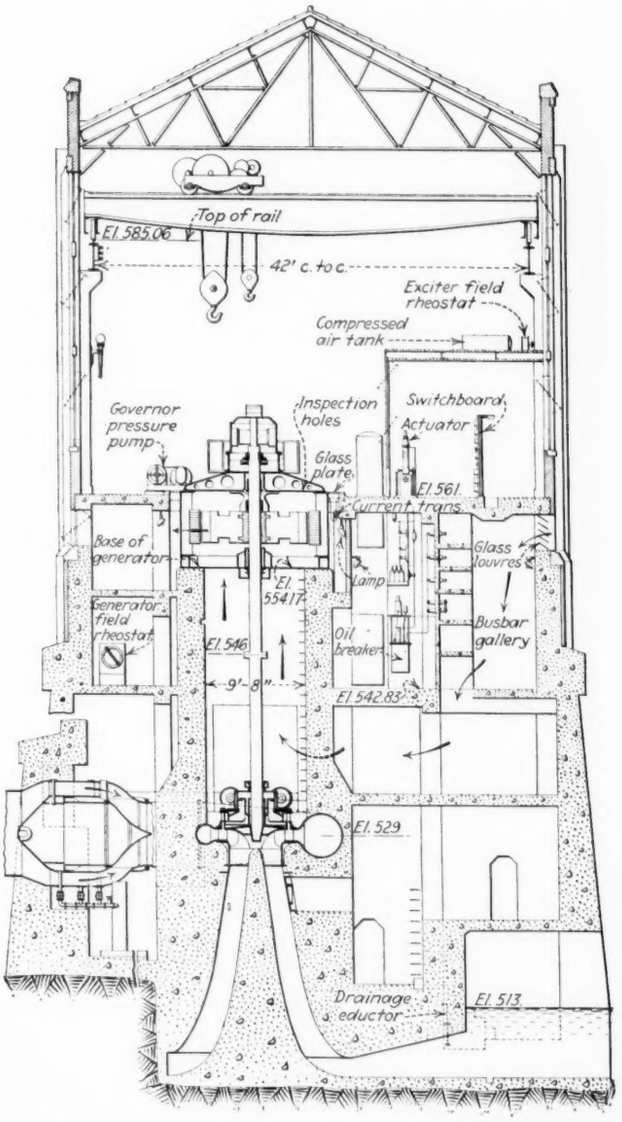


Fig. 5—All switching equipment and busbars are below the operating floor

the crane hook can be lowered and the valve parts raised to the power-house floor.

Practically all controls for the operation of the plant have been centralized in the switchboard room located on the main floor and completely inclosed by glass panels. In addition to the switchboard control for the generators low-tension feeders and the high-tension switches in the near-by substation, this room also contains the dispatcher's system layout board and carrier current telephone equipment, governor actuators which control the turbine gates, remote control for the Johnson valves, remote control for the headgate located in the intake tower, and head- and tail-water indicators.

Execution of the work for the entire development was under the general direction of G. W. Hamilton, vice-president of the Middle West Utilities Co. The project was designed and supervised by L. F. Harza, consulting engineer, of Chicago, and constructed by the L. E. Myers Co., of Chicago.

Direct-Current Motors Fail to Start—Testing for the Trouble

Causes of Motors Failing To Start When Both the Field and Armature Circuits Are Complete—Testing for Open-Circuits in the Field and Armature Circuits and Short-Circuits Between Series-and Shunt-Field Windings

By B. A. BRIGGS

WHEN starting a direct-current motor with a manual-type starter, the switch is closed, the arm on the starting box is brought on the first point, as in Fig. 1, and the motor is given an opportunity to get the load in motion before moving the arm farther. If the motor does not start, the arm should be allowed to drop back to the off position, the switch opened and an investigation made to ascertain why. The first thing to determine is if the load can be started. Assume that it has been tried by hand and found free to move and that the motor fails to start it. Also assume that a heavy spark occurs when the starting-box arm is allowed to fall back off the first contact. In this article the motor is assumed to have been operating satisfactorily and to have failed to start again after it had been shut down.

Testing for Open Shunt Field Circuit

The heavy spark would indicate that probably the shunt-field circuit is open. To test for this condition, open the armature circuit at the starting box, close the switch and again bring the starting-box arm upon the first contact as in Fig. 2. Assume that when the arm is allowed to drop back no arc is obtained. This would indicate that the shunt-field circuit is open. To locate the fault, with the arm on the first point of the starting box connect a lamp as indicated at *B* in the figure. This bridges the circuit through the starting

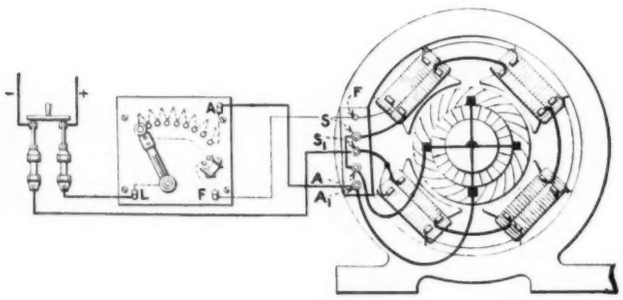


Fig. 1—Diagram of compound motor connected to manual-type starting box

box, and if the fault is in this part of the circuit the lamp should light.

If the lamp does not light when connected as at *B*, Fig. 2, it indicates that the field circuit is open somewhere outside the starting box. It will be advisable to inspect the connections at the motor and between the shunt-field coils to see if any are broken. Should the fault not be found at any of these connections, then by connecting a lamp across each field coil, as indicated at *C*, the lamp will light when connected across the faulty coil. It is then a matter of removing the coil, and if the open cannot be located when its insulation is removed, it will be necessary to replace the coil with a new one.

In Figs. 1 and 2 a compound motor is shown, but the same test would apply to the field coils of a shunt motor.

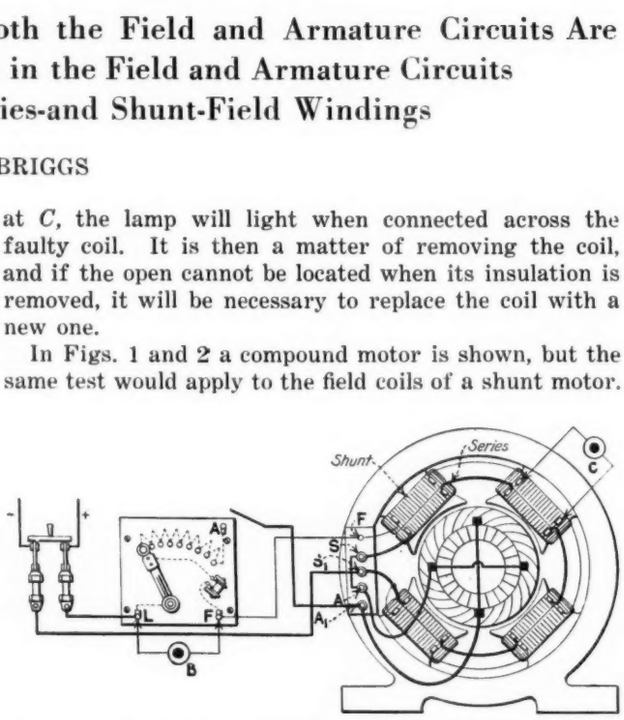


Fig. 2—Testing for open-circuit in shunt-field winding of compound motor

An open-circuit in the shunt-field coils of a compound motor will not prevent it from starting unless it is heavily loaded, or the series-field winding is light. When a compound motor does start with the shunt-field circuit open, it probably will not accelerate as quickly as normally, and if it does a dangerously high speed will be attained before the starting resistance is all cut out. When the motor is loaded and starts, it generally acts in a sluggish manner and the starting resistance gets excessively hot owing to the large current required to start the motor with the series field only.

Testing for Open in Armature Circuit

Assume that when the starting-box arm was brought on the first point, with the armature circuit open as in Fig. 2 a spark occurred when the arm was allowed to return to the off position. This would indicate that the field circuit was closed and probably the fault was in the armature circuit. An open in the armature circuit can be tested for by disconnecting the field wire at the starting box and bringing the starting-box arm on the first contact, as in Fig. 3. If the starting-box arm is allowed to remain in this position for a short time and the armature circuit is complete, the starting resistance will get hot, or if the arm is allowed to drop to the off position a heavy spark will be obtained when the circuit is broken. The absence of the heating or the spark would indicate that the armature circuit is open. Assume that the latter is the condition.

One place where the armature circuit is likely to be open is in the starting box. An open in the starting resistance can be tested for by connecting a lamp as at *B*, Fig. 3, with the arm on the first point. If there is an open in the starting box the lamp will light. When an open is in the starting resistance the exact location may be determined, as indicated in Fig. 4. Assume the open is in the starting resistance as at *X*, then if one lead of the test lamp is connected to terminal *L* on the starting box and the other is touched to the contact buttons, when in contact with those to the left of *X* no light will be obtained, but when in contact with those to the right of *X* the lamp will light. In the latter case the circuit is completed from the + side of the line through the lamp, armature, series-field winding and to the — side of the line. Since, when the lamp is connected to contact *a* no light is obtained and it lights when connected to *b*, it indicates that the open is in the section of resistance connected between these two contact buttons. If the resistance unit is of such a type that the fault cannot be located and repaired, then it probably will be satisfactory to short-circuit this section out by connecting a jumper from *a* to *b* on the back of the panel.

Testing for the Fault in the Motor

Assume that when the starting box was tested as in Fig. 3 it was found in good condition, then attention should be given to the motor. The first thing to do is to examine all the connections to see that they are in good condition and that none is broken, also that the brushes are making good contact with the commutator. If the defect has not been found by this examination, then the various parts of the armature circuit may be tested as indicated in Fig. 5. The shunt field and armature wires running from the starting box are disconnected at the motor and one lead of the test lamp is connected to the armature wire. With the switch closed and the starting box arm on the first point, the other terminal of the lamp is connected to S_1, this connects the lamp directly across the line, and it should light

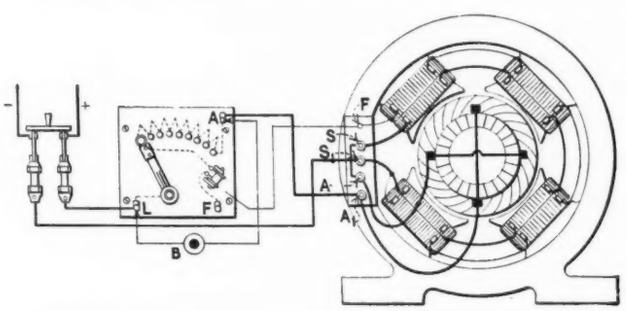


Fig. 3—Testing for open-circuit in armature circuit of compound motor

if the circuit is complete. Assume this to be the condition. Then the free lead of the lamp may be connected to terminal *S*. This puts the series winding in circuit, and if it is complete the lamp should light. Failure to light indicates an open in one of the coils. The coil at fault can be located by connecting the free lead of the lamp between the coils. For example, by connecting the free lead to coil terminal *B*, this coil only is in circuit. If the lamp were to light on terminal S_1 and not on *B*, it would indicate that this coil is open-circuited.

Having found coil *B* in good condition, connect the free lead of the lamp to *C*. A light indicates that the coil is complete and its absence that the coil is open-circuited. When the faulty coil is located, it should be removed and repaired or replaced by a new coil.

In large machines an open-circuit is not likely to occur in the series-field winding on account of the large-sized conductors used, unless the motor is subjected to heavy vibration or other abuses. On small machines the wire in the series-field coils is of comparatively

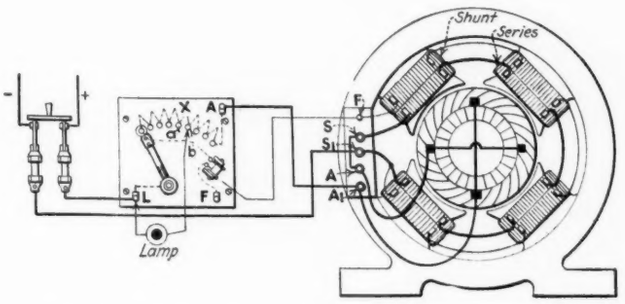


Fig. 4—Testing for open-circuit in starting box

small size and is more likely to fail. However, an open-circuit in the series field coils of a compound motor is a rather rare occurrence.

When the lamp Fig. 5 is connected to the *S* terminal of the motor if the series-field windings tested complete, then the free lead of the lamp may be connected to A_1 terminal of the armature. This puts the armature in circuit with the series-field coils, and if the former is complete the lamp should light. It is rare that this part of the circuit will be found open except in small machines.

Open-Circuit in Armature

An open-circuit in the armature winding will not show up as an open-circuit in the armature at the motor terminals unless the machine is a small two-pole type. Even in such a machine the armature winding has to be open in more than one place before it will test open with a lamp. Not unless the brushes and commutator were in extremely bad condition would it be likely that an open-circuit through the armature would be caused by the brushes making poor contact, except in a small machine with only two sets of brushes. In the latter case the brushes may stick in the holders clear of the commutator when the motor is shut down, especially if the commutator is eccentric. When an attempt is made to start the motor again, the armature circuit will be open. This generally can be remedied permanently by cleaning the brushes and brush-holders.

Another place where the armature circuit could be open is where the leads, from the brush-holder studs to the motor terminals, are soldered into their lugs. In some cases the soldering is not done properly and after a time the connection becomes so badly corroded as to cause an open-circuit.

Assume that a test has been made for an open-circuit in the shunt-field circuit and in the armature circuit as in Figs. 2 and 3 respectively and both these circuits are found complete, but the motor fails to start. There are a number of conditions that could cause this. First, the load not being free to start either due to abnormal conditions in the load, the bearings of the

motor set on the armature shaft, or the bearings worn so as to allow the armature to come in contact with the pole faces. A short-circuit of a group of coils in the armature would prevent the machine from coming up to speed although the armature will generally start to revolve but will act as if the motor were heavily loaded. In such a case heating of the starting-box resistance and of the armature winding generally results.

Another cause of a compound motor failing to start is a short-circuit between the series and shunt-field

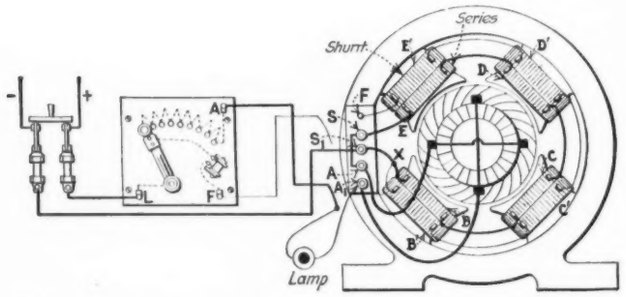


Fig. 5—Testing for open-circuit in armature connections and series-field winding

windings. The effect of such a short-circuit will depend on where the fault occurs. For example, if the defect was between coils B and B', Fig. 5, it would probably not be noticed, since only a part of this one shunt-field coil would be cut out of circuit. Should the fault occur in coils E and E', then at least the shunt-field coils on the other three polepieces would be cut out of circuit and probably part of the defective coil. Such a condition would cause serious heating of the defective shunt coil and the holding coil on the starting box.

Testing Series and Shunt Coils

A test can be made for a short-circuit between the series and shunt-field coils by opening the connection X in Fig. 5 and with the free lead of the lamp touch terminal F of the shunt coils. If there is a breakdown in the insulation between the series- and shunt-field coils, a light will be obtained. Should the lamp light, the defective coil can be located by disconnecting one of the shunt coils at a time. For example, if coil B' is disconnected and the lamp remains lighted, it will be known that the fault is not in this coil. When coil C' is disconnected, if the lamp goes dark then this is the defective coil.

Another cause of the motor's failing to start is grounds in the motor winding with the frame of the machine grounded and also a ground on one side of the line. This will generally be accompanied by heating of the starting box or an opening of the fuses on circuit breakers. A ground in two different parts of the motor such as in the shunt field and in the armature would cause it to fail to start even though there were no other grounds on the system.

On different makes of motors different arrangements of terminals are used, therefore the foregoing applies to direct-current motors in general and no specific make. When applying the tests, care must be exercised to identify the terminals and wires, and when leads are disconnected that may be made alive, they should be insulated with tape to avoid the chances of causing short-circuits. Care in making tests contributes much to the results obtained.

When Metals Pull at Their Own "Boot Straps"

It has long been known that "season cracks" in brass tubing and rods may be caused by internal stresses set up in cold working.

These stresses may be quickly removed by annealing, but the ordinary high-temperature anneal produces a softness which is frequently not desired. The extensive use of brass for military purposes directed special attention to this problem early in the war. Since that time it has been the subject of repeated investigations.

The practical solution has been found in the form of a low-temperature anneal, the temperature and time being carefully adjusted to release most of the internal stresses without serious detriment to the hardness.

All the internal stresses in a body must balance. The whole mass of a round bar could not be subjected to an internal longitudinal stress for example. There can be no pull without something to do the pulling. But the outer shell may be in compression and the inner core in tension, the push of one balancing the pull of the other. It is much as when a man's vain effort to lift himself over a fence by his boot straps produces internal stresses in his body, the pull in his arms balancing compression in his legs.

Cut the boot straps and both stresses are relieved. The same method is used to measure internal stresses. In the rod just mentioned the core might be drilled out. No longer having anything to push against, the shell would grow longer. The increase of length would of course be very small, but its measurement by refined methods would indicate the size of the stress originally existing in the shell of the rod.

There are, however, methods of exaggerating the slight expansions and contractions that occur. The slight expansion by heat of one side of a sheet of paper produces a marked curling. Another illustration of this method of magnifying small movements is the thin compound strip used in thermostats.

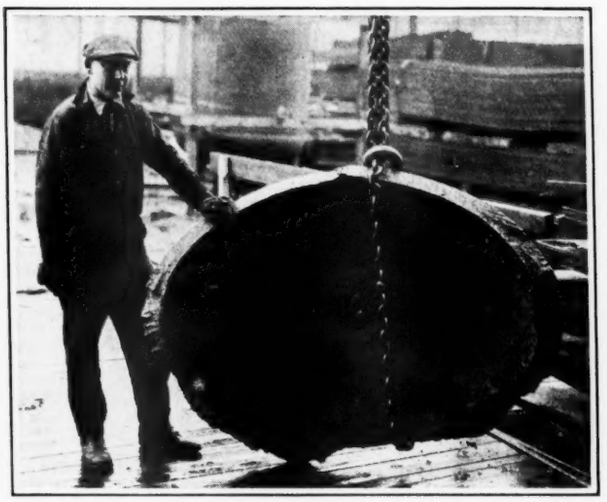
These illustrations bear a striking resemblance to a method now used for detecting internal stresses in brass tubes. By cutting two parallel longitudinal slots about six inches long and one-half inch apart and by connecting the slots with a cross cut at one end, a tongue of brass is relieved of the constraint of the adjacent walls, standing free like the tooth of a comb. If before the cuts are made the inner layer is in compression and the outer in tension, these stresses will be relieved in large part by the cuts, and the free end of the tongue will spring out a considerable distance from the surface of the tube.

Now it is evidently practicable to anneal successive samples at gradually increasing temperatures until a point is reached where the tongue of metal will show no appreciable movement when cut free. The samples thus tested for internal stress can likewise be tested for hardness, tensile strength, elastic limit, ductility, etc. Study of these data for various annealing conditions makes it possible to locate the narrow zone where most of the internal stresses are relieved with but little effect on the hardness or related properties.

The most recent experiments along this line are reported in the Bureau of Standards Technologic Paper No. 285 entitled, "Release of Internal Stress in Brass Tubing," by Robert J. Anderson and Everett G. Fahlman.

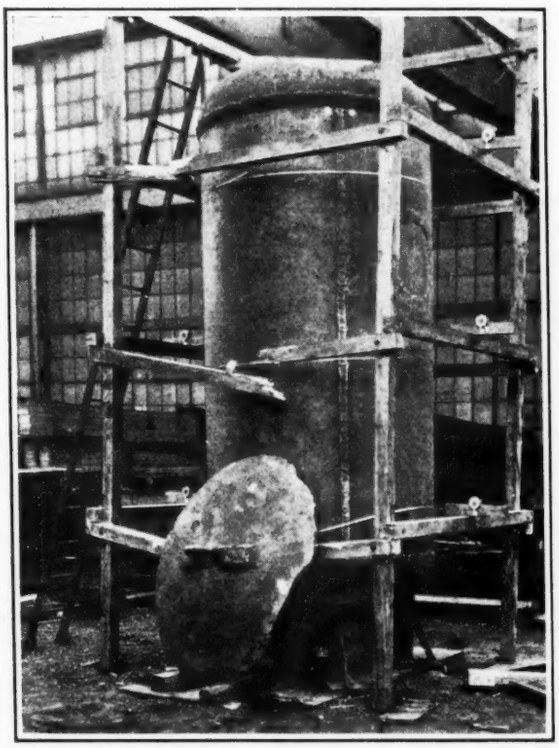
Electric Welds Hold in Test of Still

Bottom of the tank, showing end of one of the vertical welds and the "orange-peel" welds used in forming the curved surface

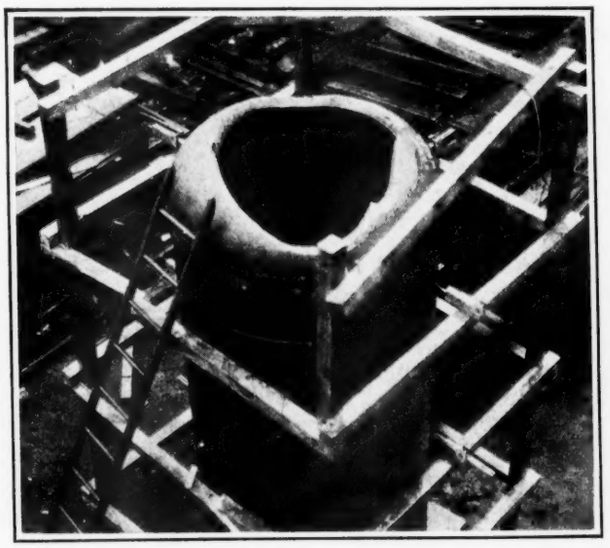


This hunk of cast steel was blown fifty feet into the air

To determine the value of electric arc welding on the heavier thicknesses of steel, the A. O. Smith Corporation in Milwaukee recently made a test on a cracking still 10 ft. 6 in. high and 5 ft. inside diameter with a shell 2½ in. thick. The shell was made of four plates joined by longitudinal welds. At a hydrostatic pressure of 4,700 lb. an oval piece 46 in. by 3 ft. 6 in. from the 3½-in. thick cast-steel head was blown 50 ft. in the air. All welds held and showed no leaks whatsoever, the remainder of the vessel being intact. The pressure of 4,700 lb. corresponds to a fiber stress of 56,400 lb. per sq.in. in the longitudinal welds.



Tank after destruction, showing piece blown out of head. No other part of the tank was injured



View from above, showing hole in cast-steel head which ruptured at a fluid pressure of 4,700 lb.

Unaflow Engine with Hydraulic Valve Gear

THE HYDRAULIC rams for the opening and closing of steam-engine valves have been in use in England for some years, but it is only recently that such a design has been developed in this country.

The Chuse Engine Co. in 1924 designed a hydraulic gear for a 750-kw. duplex unaflow steam engine for installation in the Mengel Lumber Co.'s mill at Baton Rouge, La.

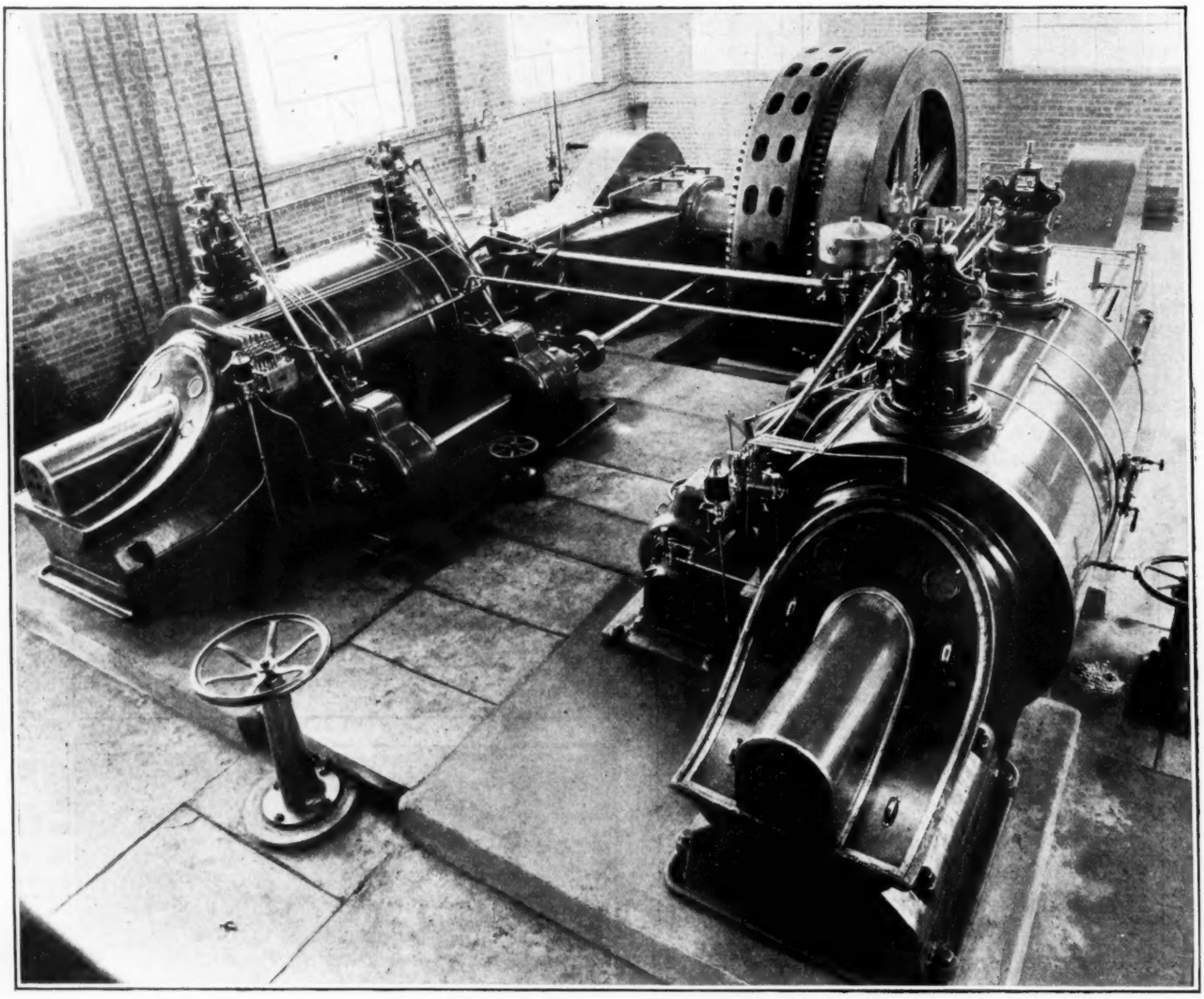


Fig. 1—Unaflow engine with hydraulic gear installed in Mengel Lumber Co. plant, Baton Rouge, La.

This engine, which is shown in Fig. 1, is provided with heavy one-piece frames, to which are bolted the cylinders. The pistons are provided with tail rods whose slippers rest on guides formed by extending the cylinder-head castings much after the fashion in larger gas engines. These head castings are so designed that by unbolting the cylinder covers the latter may be removed, as may also the pistons and rods without disturbing the main head casting.

The valve-gear eccentrics are placed on layshafts running along the engine frames and driven by bevel gears on the crankshaft alongside the main bearings.

The valve itself is the Chuse Standard poppet valve, but the hydraulic gear is new.

Fastened to valve stem *A*, Fig. 3, is piston *B*, which at its upper end forms a cylinder for the oil ram *C*. It also has an annular extension *D*, the purpose of which will be referred to later.

The oil ram *C* has a Scotch yoke connection to the lever *M* and through these parts is moved by a fixed eccentric mounted on the layshaft. Its lower part is hollowed out and provided with release ports *E*. A

sliding sleeve *F* has a nice fit on the outside of the oil ram, and the position of this sleeve is controlled by the governor through the bellcrank *O*.

The oil piston *B* works in a cylinder formed in the bonnet casting, the diameter of the cylinder bore being larger than that of oil ram *C*. A check valve *H* is arranged so as to admit oil from the reservoir *I* into the chamber *K*.

During the down stroke of the oil ram *C*, oil pressure is created in spaces *L* and through the passage *G* in *K*, and owing to the difference in area between the under side of the piston *B* and the oil ram *C* the steam valve is lifted. This movement continues up to the point where the release ports *E* are uncovered by passing the lower edge of the sleeve *F*, whereupon the oil flows up through the hollow ram *C* and through *E* into the reservoir *I*, and the steam valve closes, owing to the action of the valve spring and the unbalanced pressure on the valve.

At the point of seating, the extension *D* of the oil piston *B* creates a dashpot action and thereby cushions the valve. The amount of this cushioning action is adjustable by means of the connection between the oil piston and the valve stem.

During the further down stroke and during the first part of the up stroke of the oil ram *C*, oil is being transferred from the reservoir to the cylinders and vice versa, up to the point where during the up stroke of the oil ram the release ports *E* are again covered by the sleeve *F*. At this point the oil ram will tend to pull a vacuum, the presence of which naturally would make the mechanism inoperative. For this purpose a

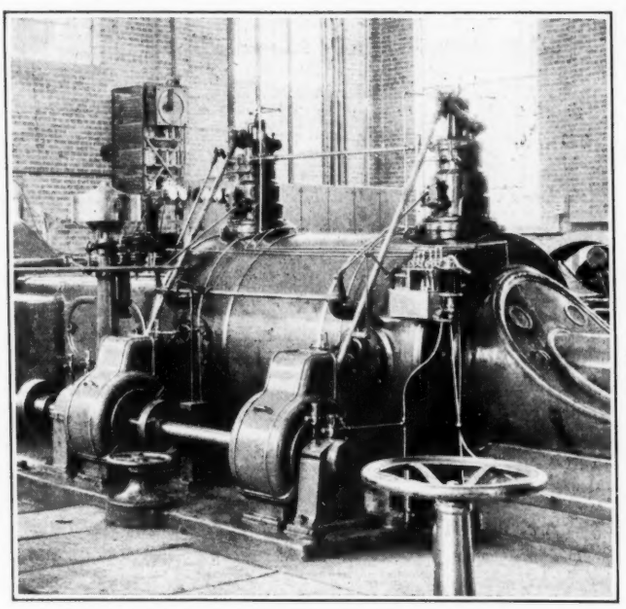


Fig. 2—View of valve gear and layshaft

check valve *H* is provided which will admit oil from the reservoir to the working chamber whenever the pressure of the latter falls appreciably below atmospheric pressure. It naturally also follows that whenever the check valve is held open or prevented from closing, the oil ram will be unable to create pressure, and therefore the steam valve will remain closed.

This feature has been used to provide a simple safety stop for the engine. A small eccentric is located below the check-valve stem and is moved up whenever a small centrifugal governor on the layshaft trips the safety-stop mechanism. The check valve is then held open and the engine is being shut down.

The Chuse Company has since developed a hydraulic gear of which all the parts are assembled in a unit

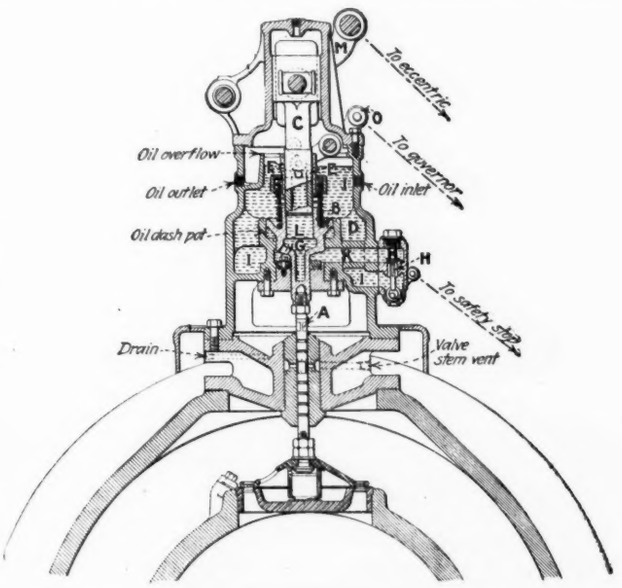


Fig. 3—Cross-section showing the parts of the hydraulic gear

at the side of the cylinder, with an oil line leading to the plunger on each valve stem. This latter gear has the advantage of concentrating into one unit all the pumping and governing mechanism needed to handle both steam valves, and eliminates danger of valve misadjustment due to temperature changes.

Water Column Attachments

The A.S.M.E. Boiler Construction Code lays down the following regulations regarding outlet connections on pipes leading to water columns. "P-295—No outlet connections, except for damper regulator, feed-water regulator, drains or steam gages, shall be placed on the pipe connecting a water column to a boiler." This is further clarified in the following inquiry and reply in Case No. 484, recently reopened.

Inquiry: Is it permissible to connect a low-water signal or alarm of the whistle type to the water-column or water-gage connections of a boiler?

Reply: It is the opinion of the Committee that Par. P-295 of the Code does not permit the connection or attachment of any form of apparatus to the pipes connecting a water column to a boiler that may under any conditions allow steam to escape therefrom. This applies only to devices or attachments other than those enumerated in Par. P-295, and it is not to be construed that it will prohibit the use of feed-water regulators, damper regulators, or high- and low-water alarm devices in which there is no appreciable flow of steam from the connecting line.

The present serious shortage of power in the South occasioned by low stream flow, emphasizes once more the necessity of interconnection and the dependence on steam as a stand-by. Those who have been proclaiming unlimited and cheap hydro power, especially in connection with Muscle Shoals, would do well to take note.

Equalizing Combustion in Diesel Cylinders

By Robert Melrose

Balancing the power in the cylinders of a Diesel engine is a delicate operation which can best be accomplished by a careful study of the indicator diagram. It is first of all necessary to insure that combustion conditions are as nearly perfect as possible in all cylinders before any attempt is made to alter the quantity of fuel supplied to any particular cylinder.

Two cylinders may both be receiving the same amount of fuel, but on analyzing the indicator diagrams, it is found that one of them shows a higher mean indicated pressure than the other. Further investigation is now necessary. The exhaust or air inlet valve may be leaking, conditions that will be indicated by an excessive exhaust temperature or a blow back at the air inlet. The piston rings may be worn, reducing the final temperature of compression, by allowing some of the air to escape and by the same means reducing the mean pressure during the combustion stroke. The fuel-valve spindle packing may be too tight, preventing the valve from functioning properly, or the timing may be incorrect. It has been found by experiment that a slight difference in combustion conditions has been obtained in two cylinders on the same engine by having the holes of the pulverizer plates staggered in one case and all in line in the other.

When the operator has satisfied himself that conditions are approximately correct and that the mean effective pressures of the cylinders are still at variance, he can adjust the amount of fuel delivered by altering the tappet regulating the time of lift of the suction or spill valve on the fuel pump. This adjustment can be accomplished on some engines while in motion, but the operation should be carried out with extreme care.

In conjunction with exhaust temperature, indicator diagrams are invaluable for deducing combustion conditions, and for this reason it is the practice of some manufacturers to supply pyrometers with their engines. These pyrometers usually consist of a thermoelectric couple placed in the exhaust passage between the exhaust valve and the manifold, with the indicating dial located on the control board.

Previous to starting up a Diesel engine, it is necessary to insure that the fuel system is primed with oil up to the fuel-injection valve. This procedure will assist in conserving starting air, as the initial impulses of the fuel pump will be utilized in supplying oil to the cylinder instead of filling the fuel line. However, even in this apparently simple operation there is scope for a certain amount of malpractice. In the majority of engines a bypass valve is fitted on the fuel line in close proximity to the fuel-injection valve. When priming the engine, this valve should be opened, and as soon as oil makes its appearance, it should be closed. The appearance of oil at this point denotes that the system is free of air and also that the fuel line is filled to its highest point. Operators, to save time, often make a practice of priming their engines without going to the trouble of opening this bypass, with the result that the engine cylinder gets an overcharge of oil, as it is impossible to determine when the system is properly primed. A dull knock is heard when the engine starts to fire, accompanied by lifting of the relief valve and black smoke issuing from the exhaust pipe.

It may be reasoned that this procedure is most serious with inward opening fuel valves, that is, valves that open into the cylinder as distinguished from the needle type. This is true to a certain extent, but if the oil cannot escape into the cylinder, it will fill the fuel valve and blast-air pipes up to the non-return valve in the air line, and engines have been known to run away by reason of the inability of the governor to control this oil supply.

Convenient Steam Charts

By L. H. Jones

QUITE often one is interested only in a given section of the Mollier steam chart and in certain properties of the steam. The many intersecting lines on the Mollier chart produce a confusion that is, for some purposes, unnecessary. In fact, many engineers prefer to interpolate directly from the steam tables.

By plotting the desired properties in the required range, simple curves can be made up that will eliminate

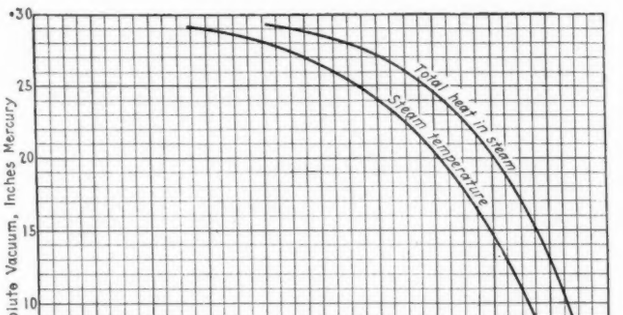


Fig. 1—Temperature and total heat of saturated steam under vacuum

considerable work and chance of error. Such charts may be easily constructed, by taking the main points directly from standard steam tables and drawing smooth curves.

For example, in boiler work entropy is practically a useless property, and pressure, temperature (or superheat) and total heat are the essential properties. These three make a simple set of curves, which for the range of operation make short work of steam calculations. Four arrangements that have been found particularly useful by the writer are shown in the accompanying cuts.

Fig. 1 gives the temperature and total heat of saturated steam under conditions of vacuum, and is useful in obtaining these values quickly without interpolation.

Fig. 2 represents the pressure, temperature and total heat of superheated steam, with absolute pressures as ordinates, temperatures as abscissas, and curves of total heat. This chart is useful in calculating factors of evaporation with superheated steam.

Fig. 3 gives the same arrangement for saturated steam of varying qualities.

Fig. 4 is an interesting arrangement giving the heat content of water and steam for different pressures and temperatures. The ordinates are total heat

above 32 deg. and the abscissas are temperatures, while the curves represent lines of constant pressure. From this diagram the heat of the liquid, latent heat of vaporization, and the total heat can be obtained for any pressure or temperature. It also presents a rather pressure from another. This merely shows that for a given temperature the total heat of superheated steam varies only slightly with variations of pressure. However, these lines have been inserted for the sake of completeness. For determining actual values of the total heat of superheated steam, Fig. 2 is more convenient.

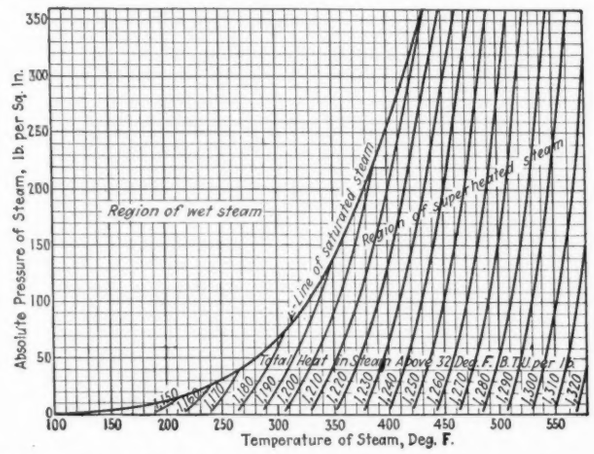

Absolute Pressure of Steam, lb. per Sq. In.
Temperature of Steam, Deg. F.
Region of wet steam
Line of saturated steam
Region of superheated steam
Total Heat in Steam Above 32 Deg. F. B.T.U. per lb.

Fig. 2—Total heat of dry-saturated and superheated steam for various pressures and temperatures

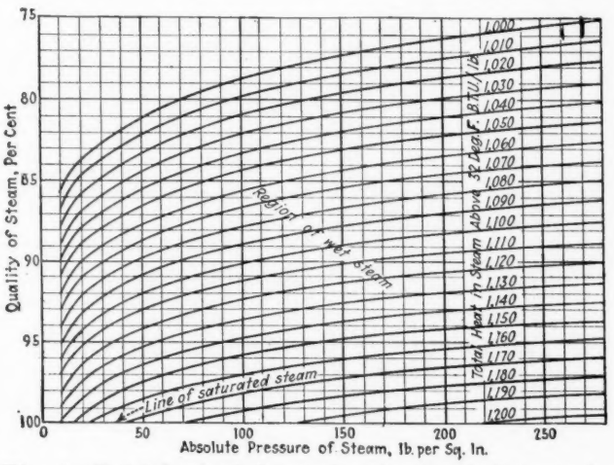

Quality of Steam, Per Cent
Absolute Pressure of Steam, lb. per Sq. In.
Region of wet steam
Line of saturated steam
Total Heat in Steam Above 32 Deg. F. B.T.U. per lb.

Fig. 3—Total heat of dry and wet saturated steam for various pressures and qualities

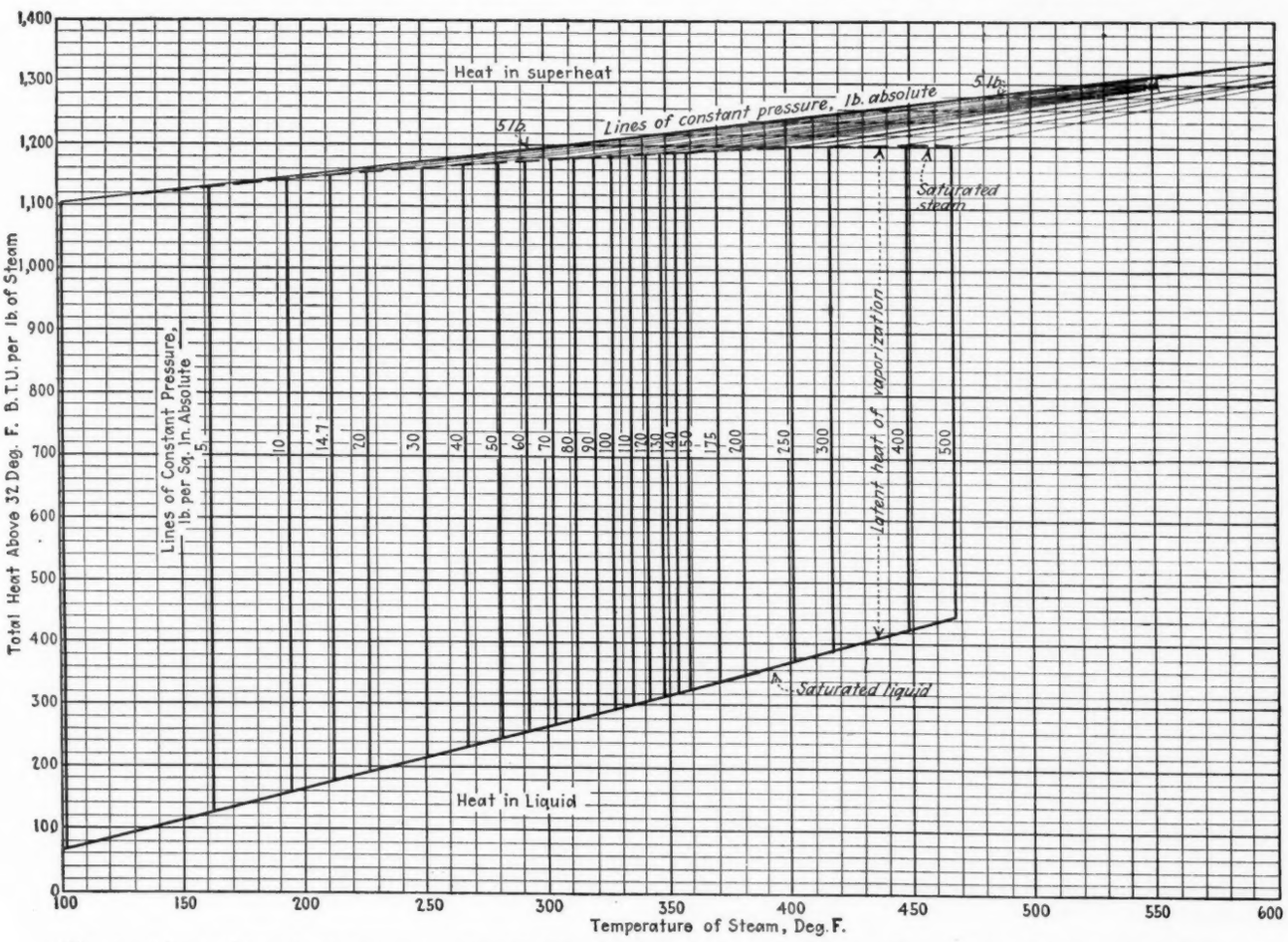

Heat in superheat
Lines of constant pressure, lb. absolute
5 lb.
Saturated steam
Lines of Constant Pressure, lb. per Sq. In. Absolute
Latent heat of vaporization
Saturated liquid
Heat in Liquid
Total Heat Above 32 Deg. F. B.T.U. per lb. of Steam
Temperature of Steam, Deg. F.

Fig. 4—Lines of constant pressure, showing the changes in temperature and total heat during the change from the liquid condition into superheated steam

interesting comparison of the amounts of heat required to heat water, evaporate it and superheat steam at various pressures.

It is true that this diagram is not all that might be desired in the region of superheat, the lines there coming so close together that it is hard to distinguish one

Where a boiler works continuously within narrow limits of feed temperature and steam pressure and temperature, similar diagrams may be constructed on a much larger scale, covering the desired range.

Defrosting Coils in Refrigerator Boxes

By Roland L. Tullis

AT THE present time one of the greatest disadvantages of the modern refrigerator is the necessity of defrosting the evaporating, or expansion, coils at regular intervals. However, some engineers stick to the erroneous idea that the more frost on the evaporating coils the greater the refrigerating effect or the colder the room temperature. They should be reminded that keeping the evaporating coils of a refrigerator free from any great amount of frost or ice is just as important as keeping boiler tubes free of scale.

Efficiency Requires that Coils Be Kept Free from Ice

Ice on the coils acts as an insulator, prevents the rapid evaporation of ammonia inside the coils and prevents the absorption of heat from the room to be cooled. If a refrigeration plant is to operate efficiently, the evaporating coils must be kept as free of frost or ice as possible, although sometimes this is easier said than done.

I was once called in to investigate a refrigeration plant in a large hospital. It consisted of a vertical, inclosed, single-acting compressor of 12-ton capacity and furnished refrigeration for a number of cooling boxes in the kitchen. In addition, it was connected to a small brine tank which supplied ice for the institution.

The management explained that the plant had operated satisfactorily for the first few months after it had been installed, with the exception of the ice-making capacity. It had always refused to make the required amount of ice, and lately they had been unable to hold the proper temperatures on the refrigerators. The compressor apparently was in good condition, being smooth and quiet in operation. Placing an ear to the suction line offered no evidence of leaking valves or internal complications. However, I noticed that the suction line at the machine and the lower half of the cylinders were heavily coated with frost. Touching the discharge line from the compressor disclosed the fact that it was very cold.

The operating engineer suggested that frost on the suction line showed that everything was working nicely. The low-pressure gage showed close to 35 lb., by no means a good suction pressure for making ice. I suggested to the operating engineer that some of the expansion valves were possibly open more than necessary, causing a lot of liquid to be pulled over to the compressor. The reply was that the expansion valves on the refrigerators had to be kept wide open to hold the temperatures down.

Condition of Refrigerators

The next move was to examine the refrigerators in the kitchen. The boxes were well constructed, having a 4-in. cork-board insulation and were cement plastered inside and out. The doors were in good repair and well fitted. The boxes were cooled by direct-expansion coils hung on the ceiling and completely hidden from view by a large drip-pan made of wood, and metal lined. The pan was equipped with a ¾-in. drain pipe and a gooseneck trap, which connected to a near-by sewer line. Securing a step ladder and flash light, I eventually succeeded in squeezing my head in between the pan and the wall. The coils were literally incased in a solid block of ice.

The high temperature of the boxes was caused by the ice insulation on the coils, and the frosted condition of the compressor cylinders and the suction line was due to the fact that the evaporating or cooling coils were unable to boil or gasify the ammonia liquid properly, the compressor pumping a lot of liquid. The ammonia compressor was designed for dry compression, not wet, and re-expansion of the ammonia liquid in the cylinders greatly reduced its volumetric efficiency. Fortunately, the compressor was able to handle the liquid, being equipped with false heads.

Defrosting the Coils

The next problem was to remove the ice from the coils. All the boxes could not be defrosted at the same time, for, as is usually the case, they were filled with perishable goods that had to be kept in cold storage. The only thing to do in such a case was to remove the goods from a single box and defrost this before touching the others.

The boxes were not equipped with a hot-gas connection for use in defrosting; neither was there any drain in the floor of the boxes. As they were situated on the second floor of the building, it was impossible to use a hot-water hose for fear of flooding the lower rooms and the coils were in such an inaccessible position that it was impossible to remove the ice with calcium chloride. We finally decided that the easiest way out of the difficult situation would be to install floor drains in the boxes, as the ¾-in. drains in the pans would not carry away any great amount of water. Therefore, floor drains were installed in all the boxes, equipped with gooseneck traps to prevent warm air or foul odors from entering. A stream of hot water applied to the ice quickly melted it off, and the boxes were eventually all defrosted. Thereafter there was no difficulty experienced in holding the temperatures, there was no more excessive frosting back to the machine, and the discharge line of the compressor was hot as it should be. Under these conditions the suction pressure could be held around 20 lb., which is favorable for making ice.

Brine Agitator Installed

Examination of the ice tank showed that no means were provided for agitation of the brine. The operating engineer explained that the plant originally had a brine-circulating system, but the old boxes and the circulating system had been torn out. He failed to realize that the old brine-circulating pump had answered the purpose of an agitator, for it had taken its suction from one corner of the tank and had discharged in the opposite corner. A small motor-driven brine agitator was purchased and installed.

Before making any of the changes described, careful notes were made of the brine temperature in the ice tank and the number of hours required to freeze a 100-lb. cake. Previously, the brine temperature had fluctuated between 27 and 30 deg. F. and it had required from two to three days to freeze a cake. After reducing the low pressure on the machine from 32 to 20 lb. and providing a brine agitator, the brine temperature soon dropped to between 14 and 18 deg. and a cake could be frozen in 30 to 40 hours.

Elimination of Sludge in the Oiling System

ONE of the problems confronting the engineer of a steam-turbine plant has been the overcoming of lubrication difficulties. In efforts to avoid the formation of sludge, the first step has almost always been to change the brand of oil, but unfortunately the change usually has brought no relief. That the breaking down of the oil was due to oxidation is a theory that has come into general acceptance along with the assumption that unless moisture was present no sludging could occur.

This assumption has been most difficult to adopt in its entirety, for frequently sludge was found where apparently no water could have entered the lubrication system and none was found in the oil.

The subcommittee on lubrication of the National Electric Light Association's prime mover committee has tested a number of oils of various viscosities. It was found that water must be present before emulsion takes place, and the resistance of an oil to emulsifying is independent of its viscosity. It was also found that laboratory tests cannot be accepted as final in determining the suitability of an oil.

The natural conclusion to be drawn from the tests is that an oil must be chosen on the basis of its operating record in the particular plant. If sludge or emulsion is to be avoided, the closest care must be taken to prevent moisture from sealing glands and other places, entering the oiling system.

Routine

IN THE plant that operates twenty-four hours a day, the men working shift-work, what can be done to relieve the deadly monotony of this routine grind? In one group of heating plants whose periods of load alternate with periods of complete shutdown, the problem is solved by using the same men for maintenance work during the shutdown period and for operating on shifts during the load period.

Under this scheme the cost of operation is slightly increased, owing to the fact that skilled mechanics, who are needed for their ability in maintenance work, are used for operating duties that could be done as well by men of much less skill, at a lower rate of pay. On the other hand, both maintenance and operation are better cared for than they are in a plant where separate crews are employed. The maintenance man who looks forward to operating the equipment he is repairing, will be likely to do a more careful job. Likewise, the operator who must himself repair his equipment, will be careful to avoid misusing it. And there can be no "passing the buck."

On the personal side the advantage of this system is that before one has time to grow stale on a job, his work changes. The operator transfers to a straight day job involving a line of activity entirely different from that of his former work. The repairman, on the other hand, is relieved from the arduous work of overhauling machinery, to engage in the much less strenuous task of operating the plant.

The men who are responsible for the plants in question are enthusiastic over the results following from this alternation of jobs for the men. They feel that it should be possible and would be very desirable for similar schemes to be worked out for all power plants, even for those operating on a continuous load.

Is there anything in this suggestion? Would it be possible for a plant operating continuously to organize its men in four shifts, as it were—three of them engaged in operating the plant and a fourth engaged in maintenance work? Such an arrangement would give each man a turn at maintenance work in more or less regular rotation. Of course, the superintendence of both maintenance and operation might have to rest with foremen and chief engineers who remain continuously at their respective tasks. It would be interesting to hear from the readers of *Power*, whether this scheme seems to be at all feasible.

New Trends in Engineering Education

THERE may have been a time when the quantity of the product of engineering education was more important than its quality, when what the country needed most of all was a large number of fairly good engineers. Conditions have changed. The market is flooded with technical graduates. If industry has great need of their services as engineers, it does not express that need in terms of the ample compensation that should naturally follow whenever demand exceeds supply.

So it will do much for engineers in general and perhaps benefit industry as well, if the engineering schools cease, for the time being, to lay emphasis on quantity and go in for quality production. Prospective students without unusual natural qualifications for engineering work should not be encouraged to start or complete engineering courses. It may seem rather hard on a man to drop him or steer him into another course at the end of the freshman year, but really he will have been benefited if he is spared years of hopeless competition with more capable men. In brief, the engineering schools should now confine their efforts almost entirely to those who give promise of real engineering ability.

In the first era of engineering education stress was laid upon teaching the student to do the things he would have to do in later life. Drafting, surveying and shop work were looked upon as the very heart of the engineering course. More recently attention has turned

to the fundamentals. Industrial leaders and experienced engineers at last appreciate the impossibility of securing adequate practical training in a four-year college course. It is now generally admitted that time spent on the fundamentals of mathematics, physics, chemistry, mechanics, etc., will pay the student far greater dividends in later life than a half-baked and obsolescent knowledge of practical applications.

The third era of engineering education, upon which we are now entering, will continue to emphasize the fundamentals and will in addition stress the importance of research in the training of engineers. While there will always be routine engineering work to be done, for which a cut-and-dried technical training may be sufficient, such jobs must necessarily be subordinate. The worth-while jobs will be those whose holders are continually wrestling with new problems.

As pointed out by speakers at the Pacific Coast Convention of the A.I.E.E., held last week in Seattle, Wash., research training is expensive, but there are several ways in which industry can help support the type of education from which it is certain to profit so highly. Among these are the establishment of numerous research fellowships in engineering colleges, co-operative work between research departments of industrial organizations and educational institutions, the establishment of research foundations as integral parts of engineering colleges, the sabbatical exchange of engineers between engineering faculties and engineering staffs of manufacturing companies, and the taking out of patents by universities on discoveries made in their laboratories.

Of one thing there can be no question, research is coming to occupy a position of outstanding national importance. The engineering schools must face this situation in the training of their students.

Given the Stamp of Approval

POWER generation at Niagara Falls began on what may be considered a large scale in 1895, five years after breaking ground for the plant's construction. This first unit, as in the case of a number of the subsequent units, was rated at five thousand horsepower under a one-hundred-and-forty-foot head. Since that time the plant capacity has increased to where there is installed on the two sides of the Falls approximately one and one-half million horsepower, and is divided approximately, nine hundred thousand in Canada and six hundred thousand in the United States. This capacity is sufficient to pass about seventy-six thousand cubic-foot-seconds of water, which is twenty thousand in excess of that allowed by the treaty concluded between Great Britain and the United States in 1909.

This excess capacity has not been installed with any idea in mind of using more water than allowed by the treaty, but for economic reasons. In the last thirty years remarkable improvements have been made in hydro-electric unit designs, which combined with the higher heads used in the modern plants at Niagara falls, have resulted in an increased power output for a given quantity of water of from one hundred to one hundred and fifty per cent. Therefore in the work of what might be called a redeveloping of Niagara Falls, those interested in the problem have only been following the dictates of changed economic conditions, which no live going business organization can afford to ignore.

This excess capacity in the older plants is being held as reserve against emergencies. When not interfered with by outside influences, hydro-electric units have a very high degree of reliability. Experience has shown that there are many outside agencies such as floods and ice that can greatly reduce the output of water-power plants, and Niagara Falls is no exception as has been shown on various occasions. Should at some future date the treaty be revised to allow a greater diversion, the present excess capacity in the old plants will be immediately available to use at least part of this water until such time as new plants can be built or it is necessary to build such plants.

The fact that water can be diverted in excess of that allowed by the treaty has made it advisable to appoint what is known as the Niagara Control Board to pass upon questions that may arise regarding water diversion. This body was created in 1923 by the two interested governments and has recently made its report. Its findings are to the effect that the records definitely show that the diversion of water by the power companies at no time exceeded the amount allowed by the treaty limitations. This is what would be expected by those familiar with the method of measuring the water and the system of keeping records of water diversion at Niagara Falls. For many years the companies on the American side of the Falls have submitted reports of hourly measurements to the War Department.

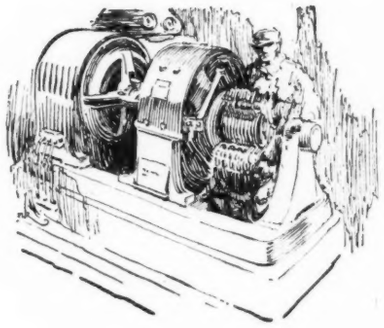
These measurements are based on the kilowatt-hour output of the units and their efficiency curves, the latter determined by test. Tests are made at intervals that will allow detecting any variation in the efficiency. Although the Board of Control has established what might be called a code of standard practice for the companies on both sides of the Falls, this practically amounted to placing its approval on the methods already in use after a careful investigation. The placing of the diversion in the hands of an International Control Board should eliminate any grounds for dispute at this time and may have far-reaching effects in the future development of Niagara Falls.

The anthracite strike has now been in progress for a month with little change in its status and apparently no great effort being made toward settlement. This is undoubtedly due to the fact that the consumer has not yet begun to feel any appreciable effects of the strike and the miner on the other hand is still in the mood for enjoying his enforced idleness. Because the public has learned to use substitute fuels, the present tieup is not likely to cause any material hardship.

Is your plant well balanced in the matter of power and process steam? Are there not some relatively simple things you could do to reduce the yearly loss of energy to atmospheric exhaust or condenser circulating water? Large savings can be effected if the winter period of complete exhaust utilization can be lengthened. The measures needed to accomplish this will also insure a smaller loss of steam during the remainder of the year.

An editor recently visited the plant of one of the best-known companies in the country and was surprised to note the total absence of any means for weighing the coal, although the plant is of nearly four thousand kilowatts capacity and supposedly modern. The management is reported to be seriously considering the purchasing of power. Is there any wonder?

Practical Ideas from Practical Men

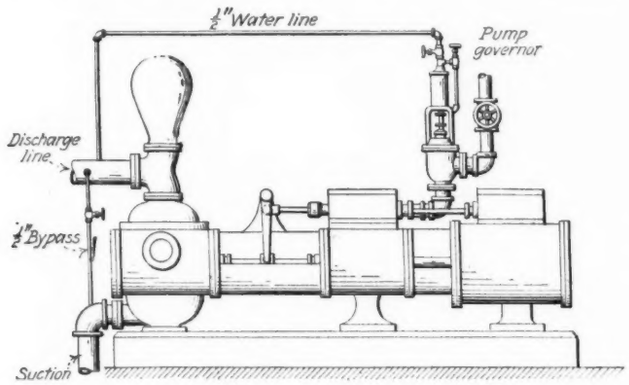


WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for August will be announced next month.

Changing a Water System from Tank Pressure to Direct-Pressure Pumping

It occurred to me that the following might be of interest to the engineers that have to solve the different problems in the smaller power plants throughout the country.

The water-works plant to which this article refers,



Auxiliary pump connected for emergency service

was built to operate against tank pressure. The tank had a capacity of 100,000 gal. and was on top of an 80-ft. tower. Later, it became necessary to extend the plant and this necessitated razing the tower to make space for more boilers. This meant that it would be necessary to come to "direct-pressure pumping."

The problem was what should be done to be doubly sure that the pressure would be maintained on the lines at all times without fail.

We were running a four million gallon high-duty pumping engine to maintain the pressure in the pipes, but should this pump fail the pressure would be gone. We had a direct-acting pump which we used as an auxiliary. We equipped this pump with a foot valve on the end of the suction line at the reservoir and put a small bypass from the discharge to the suction line so that the suction would be full of water up to the pump at all times.

We then equipped the steam end with a pump governor, connecting the pressure cylinder of the governor to the city mains and setting the governor so that if the pressure fell only a few pounds the pump would cut in and maintain the pressure in the mains.

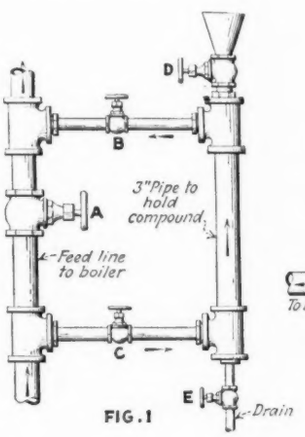
We have had this pump equipped this way for some time, and it has never failed to operate when required. There is no steam leaking, and nothing to indicate that it stands ready to cut in on the line when the pressure falls. But when the time comes, it cuts in without shock or jar and holds the pressure without assistance until the other pump is back in service. It is important in an installation of this kind that the suction be free from air pockets and full of water so that when the pump starts there will be no jar. All suction lines should gradually rise from the source of supply to the pump.

W. J. LAPWORTH,
Pittsburg, Kan. Supt. Water Department.

Two Methods of Feeding Boiler Compound

A simple method of feeding compound into the feed water, when it is not desirable that it be passed through the feed pump, is shown in Fig. 1. With this arrangement the valves *B* and *C* are closed and the valves *D* and *E* opened and the pipe allowed to drain. Then the valve *E* is closed and the pipe filled with compound. Then valve *D* is closed and *B* and *C* opened. By closing down on the valve *A*, the water is bypassed as indicated by the arrows, which forces the compound out of the pipe and into the feed line.

Another method in which an injector is used to feed



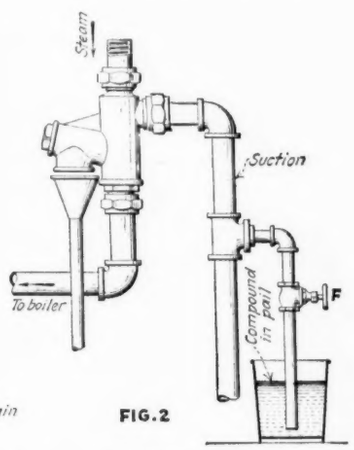


Fig. 1—Method of feeding compound on discharge side of pump

Fig. 2—Method of feeding compound with an injector

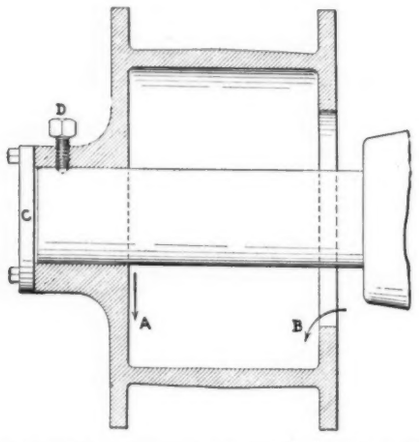
the compound is shown in Fig. 2. Once the injector is in operation, the compound can be fed at any rate desired, by regulating the opening of the valve *F*.

Needham Heights, Mass. G. M. PHINNEY.

An Improved Governor Pulley

A Corliss engine was fitted with a flywheel governor that was driven from the crankshaft by a belt according to general practice. As it carried a large center weight, in addition to the flyballs and other parts, a liberal supply of oil was needed to insure safety and sensitive operation. Much of this oil found its way to the face of the pulley and the leather belt, causing the belt to slip.

To eliminate this feature, the pulley shown in the illustration was designed and installed. The oil was



Pulley designed to prevent oil carried along shaft from reaching pulley surface

caught in the pocket, as shown by the arrow at *A*, and the centrifugal force developed, held it in the pulley until it could be wiped out with a piece of waste at *B*. The cap on the end of the pulley at *C* was made oiltight by means of ordinary packing.

The whole was a great improvement over the type of pulley usually found in this service.

New Haven, Conn. W. H. WAKEMAN.

Engine Runs Away When Steam Pressure Drops

One has heard of engines running away when the governor belt breaks or the steam pressure increases beyond the set limit or if something else in the mechanism goes wrong, but a case of an engine running away when the steam pressure drops is somewhat rare and may be of interest to readers of *Power*.

The engine in question is a regulation unaflow with auxiliary exhaust valves and unbalanced double-beat steam valves. The latter are operated by a reciprocating cam gear which is actuated by a flywheel governor. The cam mechanism comprises a roller mounted on the reciprocating slide, a cam secured to the valve stem and a valve spring tending to close the valve.

The engine normally carried about one-quarter load and the steam conditions are 200 lb. steam and 2 lb. back pressure. The engineer reported the engine to run away whenever the steam pressure dropped as low as 160 lb. Upon investigation it was found that the engineer's contention was correct. When supplied with steam of 200 lb. the engine ran quietly, but in the state of running away the steam valves would begin to hammer and be noisy. At first this phenomenon was a puzzle to everybody concerned, but in analyzing the conditions it was found that the engine was operating with about 150 lb. compression pressure and that when barred over into dead center and with open throttle, one steam valve would lift as high as the clearance in the mechanism would permit.

Indicator diagrams showed a pressure drop between the steam chest and cylinder of about 40 lb., or in other words, with 200 lb. in the steam chest the highest pressure in the cylinder at any time was not more than 160 lb.

The significance of these three conditions is as follows: The forces acting on the valve when the engine is in operation are the spring force, tending to close the valve, the steam pressure on the valve stem and the pressure on the unbalanced area of the valve. The valve-stem force with a $\frac{5}{8}$-in. stem amounts to 60 and 45 lb. with a steam pressure of 200 and 160 lb. respectively. This force acts upward and therefore tends to open the valve. The unbalanced area of the valve is about 6 sq.in., and the spring was found to exert about 20 lb. with the valve wide open.

When running with a steam pressure of 200 lb. we therefore have the following combination of forces: Tending to close the valve, spring force 20 lb., unbalanced pressure on valve 240 lb., tending to open the valve, steam pressure on valve stem 60 lb. There is therefore left a resultant force of 200 lb. acting to close the valve.

When running with 160 lb., however, the unbalanced pressure on the valve disappears and we have left 20 lb. spring force acting downward and 45 lb. steam pressure on the valve stem acting upward, with a resultant force of 25 lb., tending to keep the valve open after it has been cracked open by the cam gear. Under this condition the valve will not follow the cam movement, but will close at the point at which the increasing piston speed produces sufficient pressure difference between the steam chest and the cylinder to overcome the valve-stem force.

If the erecting man, when making the final adjustments upon putting the engine in service, had set the compression as is proper for unaflow engines, which is compression pressure equal initial pressure, the trouble would have appeared right then and not taken the operating engineer by surprise several months afterward.

Detroit, Mich. C. F. JONES.

Power-Plant Equipment Operating Conditions

Power-plant equipment is often expected to operate under conditions for which it was never designed, and in the long run it usually proves more expensive than if units properly designed for the particular conditions were installed. In one plant a 300-hp. Corliss engine operating non-condensing at 135 lb. steam pressure, was found to be badly overloaded, the cutoff as late as is possible with a single eccentric, and because of the high water rate the owner contemplated a change. The cost of a new engine was higher than his expectation and after receiving several bids, he finally decided on a larger cylinder for the engine. The new cylinder was considerably larger than the old one and in addition it was decided to operate condensing to lower the steam rate as far as possible. A 20-in. cylinder was put on in place of the old one, which was 18 in. and a second-hand jet condenser was installed. After the engine was put in operation, the vibration

and pounding were severe and the owner criticized the engineer in charge for this condition and stated emphatically that he wanted the engine to run quietly as the old one had done for twenty years. The engineer spent many nights working on the engine to obtain quiet running, but even with perfect valve setting the engine pounded badly, although the bearings were all keyed up to clearances of 6 to 10 thousandths of an inch.

Outside engineers came in to look the engine over, but could suggest no remedy. One man, however, did a little figuring and at once everyone saw the difficulty under which the engine labored. "You have now a piston area of 314 sq.in. as compared with 254 on the old 18-in. cylinder. With 135 lb. per sq.in. on one side of the piston and 26 in. of vacuum on the other the thrust per square inch on the piston is 148 lb. and the total thrust against the frame and bearings is 314 × 148, or 46,472 lb.," he informed them. "Now that would be all right if the engine were designed with that in view. But the thrust on the frame as originally installed was only 34,290 (254 × 135). You see you are now subjecting the engine structure to about 35 per cent more strain than formerly. Part of this additional strain comes from the increased piston area and part from the addition of a condenser."

The plant owner saw the logic of this and asked what was to be done. The engineer suggested reducing the steam pressure, for with 100-lb. pressure and a 26-in. vacuum there was as much thrust on the bearings as with 135 lb. on the old cylinder. The engine was henceforth operated according to this recommendation. The pressure was never allowed to go beyond 110 lb. and the engine ran quietly from then on and carried the load, but the economy was not up to the expectations of the owners.

Case No. 2 concerns two second-hand ammonia compressors that were installed for the purpose of supplying water at a temperature of 37 deg. F. to a manufacturing process and keeping the temperature in two rooms at 35 to 40 deg. F. They were purchased from a company that handled used and rebuilt machinery and were guaranteed to have a capacity of 20 tons each. Each machine was driven by a 50-hp. motor, and when warm weather came on they were insufficient to maintain the desired temperatures. The owners complained to the seller about the trouble they were having and stated that the machines were not delivering their rated capacity, even though they were operated at maximum speed. The seller agreed to send one of his engineers to the plant to check up the operating conditions and learn just what the trouble was. The plant had to run continuously from Monday morning till Saturday noon, and one machine was run over Sunday to keep the room cool.

On arriving at the plant, the first thing the engineer did was to make a note of the suction and discharge pressures and take the speed of the compressors. He secured the name of the manufacturer from the nameplate and sent a telegram asking for what class of service these machines were originally sold. He next visited the cold-storage rooms and calculated the area of the coil surface. It was not possible to estimate the coil surface in the tank while the plant was in operation. The day being Thursday, it would be two days before the tank could be inspected. The suction pressure carried was 12 lb. and the condenser pressure about 150 lb. The suction pipe was frosted clear back to the valve, and he did not attempt to open the expansion valve any farther, as the coils were evidently getting all the liquid they could evaporate. He spent all the next day examining the tank insulation and looking for leaks in the rooms, and planned to shut one machine down at a time on Saturday to examine the valves, cylinders and piston rings. The plant being closed Saturday morning, one of the machines was overhauled, but appeared to be in first-class mechanical condition.

That day about noon a letter arrived from the manufacturer. It read: "These machines have a refrigerating capacity of 20 tons each at 140 r.p.m. and 30-lb. suction pressure." The machines had been operated at the speed designated, but the suction pressure was too low to get the required capacity. He immediately went to the office to interview the owners. "Can you get your repair men to work in two shifts day and night till Monday morning," he asked. Upon receiving an affirmative answer, he told them of his plans. "You see, the capacity at a given speed is in proportion to the absolute pressure of the gas entering the cylinder. Your machines are delivering only 60 per cent of their capacity because your coil surface is so small that a low pressure and temperature must be carried in the coil. If we double the coil surface we can reduce the temperature difference on opposite sides of the pipe, thus allowing a higher suction pressure to be carried." Fortunately, a near-by supply house was able to furnish the necessary ammonia fittings and work was started at once. Extra coils were put into the tanks and the storage-room coil surface was practically doubled. The temperature formerly inside the coils was about —2 deg. F., giving a difference of 39 deg. between that and the outside temperature. By doubling the cooling surface this difference was reduced to a point where the suction pressure was nearer the manufacturer's standard. By Monday morning the plant was ready to operate, and the engineer ordered them to carry a suction pressure of not less than 25 lb. and 30 lb. if possible. The tank and rooms were brought to the required temperature in a surprisingly short time and no trouble was experienced in holding them there, although there was an increase in the condenser pressure, inasmuch as there was fully 50 per cent more gas being compressed. Of course the heat transfer was in proportion to the coil area and the difference in temperature between the low-pressure ammonia and the tank or rooms. This difference was reduced by increasing the suction pressure.

Had the plant owners not tried to economize so much on pipe and fittings when installing the coils, they would have been better off, for the saving in current consumption each year is more than enough to pay for the additional coils. In fact, if sufficient coil surface were provided, it would be possible to carry suction pressure of 50-lb. absolute, since the corresponding temperature is 22 deg. F., which is sufficiently low to cool a room to 35 deg. F. Under these conditions the machines could handle 85 per cent more gas than at 27-lb. (12-lb. gage) suction pressure, although at the higher pressure the amount of ammonia that must be evaporated in the coil is 5 per cent more, owing to the lower heat of vaporization. With a net gain of about 80 per cent it would be possible to shut down one machine at night with a consequent saving in power cost.

Springfield, Mass. ANDREW F. SHEEHAN.

Comments from Readers

Shall He Take a Chance?

The discussions in recent issues of *Power* on the comparative opportunities for good jobs and for advancement between the technically trained engineer and the man who hasn't had the advantage of a college education are interesting.

I hold no brief for the college man. But it would seem as though there must be some good reason for "the advertisements in the technical magazines presenting available positions, specifying college education as a requirement." I quote Mr. Brown from his letter in the May 26 issue. There must be something that the technically trained man gives his employer that the other falls short on. Else why would the hard-headed employer, who in the last analysis is looking for profits, cold cash results, specify a college education as a requirement?

Is it because he is of the opinion that they are an ornament to his plant, with the bell-bottom trousers and flaming neckties that so many of them wear nowadays, or is it because of the "prestige of their school," or of "social influences"? Mr. Sandstrom, writing in the Aug. 11 issue, is inclined to think it is due to the latter. But school prestige and social influence are not going to keep a man on the payroll indefinitely, at least in a plant where each man is supposed to earn his salary and show some tangible evidence of usefulness. Those things might get a job for a man and might cause the boss to watch his progress more closely than he otherwise would, but the places where prestige and influence would continue to support the job must be few and far between.

What is it, then, that tends to give the college-trained engineer the edge on the man who hasn't had these advantages? I agree with the opinions expressed by Mr. Dingin, in the Aug. 11 issue, when he says: "The go-getter, the man with initiative, the man who will take the responsibility, will get his chance whether he is a college graduate or self-educated. The latter will be as successful as the former, if he has trained his mind equally as well." And I further agree with him when he says that "Assuming that a man has educated himself, he has then to learn the most important part of all, and that is, how to sell his services."

When a man finishes a college engineering course, he usually knows something about engineering. But the practical man at the same age knows more about engineering. Further, as Mr. Sandstrom points out, he has been through a part of the mill and knows some of "the many kinks and obscure facts that can be learned only by experiments." The college man has yet to learn those. Why, then, should the practical engineer who goes after some of the college man's success, study engineering?

The college man has learned how to express himself better, both talking and writing. That immediately puts the practical man under a big disadvantage. Its importance is always underestimated by the practical man. During his four years at college, an engineer must constantly write reports, put down his observations in black and white, and then he must draw conclusions and get them on paper. In the classroom, he must think fast and clearly; he must be able to organize his thoughts quickly. The training he gets in this manner is a tremendous help to him when he gets into the plant. For that reason I would urge the self-trained man to give a lot of attention to a study of the art of expressing himself.

Again, the college man has usually had at least a smattering of economics and possibly of commerce. These have started him thinking along a little broader lines than engineering alone. They help him to see how fundamental the principles of economics are and how they govern all business activity. They help him to understand the attitude of the non-technical executive toward the power plant.

They help him to realize that if he expects a proposal, for new equipment or a change of methods in the power plant, to get favorable attention from his superior, he must recognize the difference between the "thermal efficiency" of a machine and its "financial efficiency"; he must appreciate the importance of "interest on the investment," "obsolescence charges," "depreciation," and possibly even the difficulty of getting new capital, to his proposal.

An interest in these things, and later an understanding of them, usually develops from a study of elementary economics. Such a study may seem far-fetched to the self-taught man, but he will find that it may become an important factor in his success.

And last, but far from least, comes the salesmanship. Mr. Dingin says that the self-taught man must learn how to sell his services. If Mr. Brown had learned enough of this art, he could unquestionably persuade some of the employers who advertised that a college education was required, that he could show results which would make him preferable to the college man. There are hundreds of self-taught men who are really better fitted for the jobs for which they apply than the college-trained applicants; but they don't know how to sell their services. Here, then, is another subject that should receive serious attention from the self-taught man who intends to get ahead as fast as possible. After he has learned how to sell his services to the best advantage, he can apply the same principles to the sale of his ideas to his boss.

I cannot see that the self-taught man need be discouraged at the success of the technically trained man. All he has to do is to get busy and beat the other man at his own game—take the utmost advantage of his strong points, and strengthen his weak ones. He must study the art of expressing himself, he must learn the fundamental principles of business, and he must study the principles of salesmanship. W. J. RISLEY, JR.

North Glenside, Pa.

Safety-Valve Discharge Piping

As I have always taken a keen interest in the "Safety First" movement that is now being pushed with much vigor by our most prominent engineers, I should like to make a few comments on the letter by Gordon A. Phinney on "Safety-Valve Discharge Piping" which appeared in the June 16 issue. Mr. Phinney does not say in what section of the country the arrangement of piping he shows would be satisfactory. In localities where no cold weather is known, his arrangement may be all right, but having the discharge pipes from a number of valves projecting through the roof does not look well. In this section of the country, where we get very cold weather, this method of piping would be dangerous, and no insurance company would allow it.

With regard to the danger to workmen working on the top of the boilers when the safety valve discharges into the boiler room, all safety valves will sizzle some before blowing, so there is not much danger of a workman's being in front of a valve when it blows. Furthermore, when there is no piping attached to the valve, you know there is no obstruction to prevent the valve from blowing.

THOMAS PASCOE.

Norway, Mich.

Combustion of Pulverized Coal with Different Degrees of Fineness

I was interested in the item on page 140 of the July 28 issue, taken from Bulletin No. 237, Bureau of Mines, on the efficiency with different degrees of coal fineness in the burning of powdered fuel.

It strikes me as rather curiously worded, beginning, "In the past," which would seem to convey the impression that only antiquated engineers consider that it is better to use coal pulverized to 200-mesh rather than 100-mesh. The argument advanced against such a "past" idea is, that so long as the particles are carried in suspension "it makes little difference."

Is that so? Does it make for efficient combustion if the coarse coal can be carried in suspension without being completely burned before passing through the tubes? Certainly not.

As I look at the matter, any particle of pulverized coal is merely a lump, whether as big as a pea, the head of a pin, or its point, and has to burn from the outside to the center, and the CO_2 gas layer, as it is formed, has to be scrubbed off before combustion of the entire body can be completed. Consider, therefore, that 100-mesh particles represent lumps that are eight times as large as those through 200-mesh.

While it may be true that in burning 200-mesh coal in furnaces which provide 0.4 to 0.5 cu.ft. of furnace volume per square foot of heating surface, this fineness might not show any marked advantage over 100-mesh pulverization on account of the ample time element in such furnaces, this equality of merit between 100- and 200-mesh would not be true, however, in more recently built furnaces provided with volume ratios of only 0.15 to 0.2 cu.ft. per sq.ft. of heating surface. A finer grade of coal then becomes essential.

Use of a smaller furnace volume per square foot of heating surface means a greater saving in first cost as well as in upkeep. And it is apparent that coal particles eight times as small as another quality would assure quicker and more efficient combustion with less volume requirement.

There are improved mills now available that will regularly produce 85 per cent pulverization through 200-mesh and that thereby reduce the need for abnormally high settings. It is this recent accomplishment, especially by some of the unit types of pulverizers, that in my opinion, is stimulating the more general use of powdered coal by making the cost of the complete installation more favorable in comparison with that of stokers and more practical for application under existing boilers without disturbing the present building or making extensive changes for abnormally high settings.

The argument that particles of any size can be carried in suspension without qualification as to their complete combustion is susceptible to criticism from those technical authorities whose recommendations are taken for guidance by many coal consumers. As a matter of fact, if a particle, whether 100- or 200-mesh, is completely burned within the furnace chamber, what more could be accomplished? Practically, however, ordinary common sense indicates the desirability of using coal pulverized as finely as possible under any conditions, if the means are available, for assuring its efficient combustion.

The item struck me as rather curious, because, although qualified by "must be," and "this distinction depends on depth of the furnace and velocity of the furnace gases" which is in harmony with my advocacy for the higher degree of fineness of the 200-mesh coal, its obvious purport was to lessen respect for 200-mesh coal.

H. G. BRINCKERHOFF.

Boston, Mass.

Study of Energy Conversion Leads to Startling Conclusion

The proposition for the storage of energy by dissociation of water into oxygen and hydrogen during off-peak hours, which was advanced by Mr. Lagerquist in the June 30 issue of *Power*, recalls an interesting problem that came to my attention a number of years ago in a course in physics and chemistry.

This problem related to the conversion of energy from one form to another by two different methods.

It was first assumed that a given quantity of electrical energy was converted into heat directly by the passage of a current through a conductor. In this case the following equation applies:

$$H = 0.2387\, I^2 R t \qquad (1)$$

where H = heat in calories; I = current in amperes, R = resistance in ohms, and t = time in seconds.

It was next assumed that a like quantity of electrical energy was first used to dissociate water into oxygen and hydrogen, which finally, upon combustion of the hydrogen, appeared in the form of heat.

It was natural to expect from the law of the conservation of energy that in either case the final result would be the same.

In the indirect conversion the following equation applies:

$$Q = 1.0357 \times 10^{-5} I t \qquad (2)$$

where Q = hydrogen in grams, I = current in amperes, and t = time in seconds.

As hydrogen has a definite calorific value, one is struck by the fact that in the indirect transformation the ultimate heat depends upon the first power of the

current, while in the direct transformation it depends upon the square of the current.

Referring again to equation (2), it would appear at first thought that large quantities of hydrogen or fuel could be obtained from a small quantity of electrical energy simply by using a heavy-current, low-voltage service for electrolysis.

The next thought is that there is possibly a minimum voltage required for electrolysis which would limit the amount of hydrogen obtainable for any given expenditure of electrical energy.

It further appeared that dissociation of water at one particular voltage would give a final result for the indirect transformation, exactly equal to the result obtained from the direct conversion.

This voltage is computed as follows:

In the direct conversion of electrical energy into heat,

$$H = 0.2387\, I^2Rt \qquad \text{(see equation 1)}$$

also

$$E = IR \tag{3}$$

$$W = EI \tag{4}$$

where E = potential in volts, I = current in amperes, R = resistance in ohms, and W = power in watts. Hence,

$$H = 0.2387\, I \times IR \times t \tag{5}$$

$$H = 0.2387\, I \times E \times t \tag{6}$$

$$H = 0.2387\, W \times t \tag{7}$$

The quantity of hydrogen resulting from the dissociation of water is:

$$Q = 1.0357 \times 10^{-5}\, It \qquad \text{(see equation 2)}$$

Each gram of hydrogen, when recombined with oxygen by combustion to form water, evolves 34,400 calories. The heat H_1 developed by the indirect conversion becomes,

$$H_1 = 34{,}400 \times 1.0357 \times 10^{-5}\, It \tag{8}$$

$$\text{But } I = \frac{W}{E} \tag{9}$$

$$\text{Hence, } H_1 = 34{,}400 \times 1.0357 \times 10^{-5}\, \frac{Wt}{E} \tag{10}$$

If the quantities of heat to be evolved by the two methods are to be equal,

$$H = H_1 \tag{11}$$

or

$$0.2387\, Wt = 34{,}400 \times 1.0357 \times 10^{-5}\, \frac{Wt}{E} \tag{12}$$

The quantities of electrical energy, or the watt-seconds (Wt) in the two cases were equal by hypothesis. As the expression Wt occurs as a factor on both sides of the equation, it can be dropped.

Hence,

$$0.2387 = \frac{34{,}400 \times 1.0357 \times 10^{-5}}{E} \tag{13}$$

$$E = \frac{0.35628}{0.2387} = 1.49 \text{ volts} \tag{14}$$

It thus appears that if water is dissociated at 1.49 volts, the heat liberated by burning the resultant hydrogen becomes identical in quantity with that obtained when a like quantity of electrical energy is converted directly into heat.

It would appear that if water could be dissociated at voltages less than 1.49, more hydrogen could be obtained and consequently more heat developed by its combustion than could be obtained by the direct method.

From the law of the conservation of energy this would seem to be an impossibility.

The statement appears in Prof. William Watson's "Textbook of Physics" that Le Blanc had shown that water could be decomposed at 1.07 volts at ordinary room temperatures, using platinized platinum electrodes.

I wrote Professor Watson, who at that time was professor of physics at the Imperial College of Science and Technology, London, questioning this value of 1.07 volts, submitting a numerical example to support the question.

The following is quoted from his reply:

> Your difficulty is due to the fact that you *assume* that the temperature coefficient of a cell consisting of a platinum plate in oxygen and a platinum plate in hydrogen is zero. This, however, is not the case. The coefficient is -0.0014; that is, $\frac{dE}{dT}$ (see paragraph 563 of my book) is -0.0014. Hence, at 17 deg. C. T(abs.) $\times \frac{dE}{dT} = 290 \times -0.0014 = -0.41$. The emf. of such a cell as you consider is $E = 1.48 - 0.41 = 1.07$. The converse is of course also true. What would actually happen in the case you put is that when you decompose the water by the passage of your 697 coulombs, the temperature will fall, and if the temperature remains constant you must supply heat from external sources. Hence, the apparent gain in energy over what happens when the electrical energy is directly converted into heat.

If Professor Watson's explanation be true, it would appear that an electrolytic cell operating under these conditions would act as a refrigerator, absorbing heat energy at room temperature where it has no availability for the performance of useful work; rendering it highly available for the development of work at the temperature of the hydrogen flame. This highly available heat would be greater in quantity than the direct equivalent of the electrical energy used to produce it, the surplus being the heat absorbed in the cell from the surroundings.

Apparently, the difference between the direct and indirect conversion becomes greater when it is assumed that dissociation and combustion takes place at pressures below atmospheric.

HERBERT M. SHARP.

Buffalo, N. Y.

Value of an Automatic Engine Stop

The article in the May 18 issue, entitled "The Value of an Automatic Engine Stop," calls to mind a near accident in a mill in which I was formerly employed. To drive the mill two engines were installed, but they were not equipped with automatic stops.

One afternoon the governor failed on one of the engines, and only the fact that the engineer on duty was able to get the throttle closed immediately prevented a serious accident.

I believe every engine should be equipped with an automatic stop and precautions taken to see that it is kept in proper working condition at all times. The stops should be tried out at regular intervals to make sure they will function when needed.

In one mill in which I was employed, it was the duty of the shift engineer, who was being relieved, to push a button and try out the stop before he went off duty. In this way the engineer coming on duty was assured that the stop would function properly if needed. It was also the practice of the chief engineer to try out the stops every morning when he made his trip to the different engine rooms.

It may appear to some engineers that this was taking extraordinary precaution, but I believe it pays in the long run.

L. E. MANG.

Tarentum, Pa.

Questions and Answers

Conducted by

Franklin Van Winkle

Lining Engine Shaft from Guides

Is it practical to line up an engine crank shaft from the guides planed on the engine-bed? R. E. L.

An engine is presumed to be constructed and erected with the guides parallel with the center line of the cylinder, and it would be practical to line up the crank shaft from the guides if they are known to be in proper alignment. It is better to refer all alignments to the cylinder center line derived from the counter bores as this is not subject to change from wear and bears a constant relation to the frame work of the engine; besides, greater accuracy in alignment is obtained by referring all adjustments in as direct a manner as possible to the same base line.

Reducing Peak Load on a Motor by Using a Flywheel

A machine with a heavy flywheel is driven by a 25-hp. wound-rotor induction motor. A recording meter chart shows a wide fluctuation in the load on the motor every time the machine operates. Is there anything that can be done to reduce the peak loads on the motor? R. A. D.

The ability of a flywheel to absorb peak loads depends upon how quickly the load is applied, the duration of the load and the speed characteristic of the motor. Unless the motor has a drooping speed characteristic, the flywheel cannot be effective in absorbing the peak loads. By inserting external resistance in the motor circuit, the droop in the speed can be increased. This resistance is connected in series with the armature of a direct-current motor and in the rotor circuit of a wound-rotor motor. When a sudden load comes on, the motor slows down and tends to shirk the load, which must be absorbed by the flywheel, thus relieving the motor. How much resistance is required, will depend upon the conditions, but this can be easily determined by experiment.

Greater Volume of Air Required at Higher Altitudes

What effect has an altitude of 5,000 ft. above sea level on the air supply required for a boiler as compared with requirement for the same plant at sea level? S. B.

Complete combustion of one pound of the same kind of fuel requires the same amount of oxygen at one place as at another and as the proportion of oxygen per pound of air is invariable, there must be a definite weight of air per pound of the fuel. To obtain one pound of air at sea level and at 32 deg. F., it is necessary to use 12.38 cu.ft. and at a place where the elevation is 5,000 ft. above sea level, with barometer reading about 24.7 in., reduced to 32 deg. F., to obtain the same weight and temperature of air it is necessary to use about 15 cu.ft. Hence, to insure equally perfect combustion of a given quantity of the same fuel at the place of greater elevation it is necessary to use $(15 - 12.38) \times 100 \div 12.38 =$ about 21 per cent greater volume of air. To obtain this extra volume of air supply there must be larger grate area and greater cross-sectional area of flues and stack, or the draft pressure must be increased by forced or induced draft or by employment of a higher stack.

Foundation for Outboard Bearing

Is it necessary for the foundation bed of a horizontal engine to extend under the flywheel, if the main foundations and outboard bearing pier are on good bottoms? C. M. F.

If either the foundation of the engine bed or the outboard bearing would rest on soil, gravel or loose rock, there is likely to be trouble in preserving the alignment of the engine-shaft unless both the engine bed and the outboard bearing are supported by a monolithic foundation. For this purpose concrete foundation beds for engines with outboard bearings usually are made L shaped, having the foundation for the engine bed extended under the flywheel pit and the necessary distance beyond it to receive the pier for the outboard bearing.

Water Contained by 72 in. x 18 ft. H.r.t. Boiler

What quantity of water would be required to fill a horizontal return tubular boiler within 18 in. of the top of the shell, which is 72 in. dia. by 18 ft. long and contains seventy-eight 4-in. tubes? B. C. M.

Neglecting the presence of braces, the cross-sectional area of the space that would be above the water level may be computed by the formula for finding the area of a segment of a circle, namely:

$$\text{Area in square inches} = \frac{4H^2}{3}\sqrt{\frac{2R}{H} - 0.608}$$

in which H = height of segment and R = radius, both taken in inches. As H would be 18 in. and R would be the radius of the boiler, or $\frac{1}{2}$ of 72 = 36 in., by substitution the formula becomes

$$\text{Area} = \frac{4 \times (18)^2}{3}\sqrt{\frac{2 \times 36}{18} - 0.608} = 796 \text{ sq.in.}$$

The combined cross-sectional area of the tubes would be $(4 \times 4 \times 0.7854) \times 78 = 980.2$ sq.in., and as the cross-sectional area of the shell would be $72 \times 72 \times 0.7854 = 4{,}071.5$ sq.in., the net cross-sectional area of space occupied by the water would be $4{,}071.5 - (796 + 980.2) = 2{,}295.3$ sq.in.

Hence, neglecting the relatively small space occupied by braces and stays, the volume of water required to fill the boiler within 18 in. of the top of the shell would be, $2{,}295.3 \times 18 \times 12 = 495{,}784.8$ cu.in., or $495{,}784.8 \div 231 = 2{,}146.2$ gal.

Knocking in Boiler Feed Line

What may cause hammering in the feed-pipe line from a direct steam-boiler feed pump? C. E. S.

A hammering noise may be communicated to the feed line from pounding of the pump, due to overstroking from loss of cushion on the steam end; or jumping from presence of air or vapor in the water cylinder, or from running the pump too fast for the suction lift, or from pumping hot water with insufficient head to keep the water cylinder filled without formation of vapor. Where cushioning is not under control of a cushioning valve, it can be improved by having a tighter steam piston and steam valve. Air in the pump cylinder generally can be removed by heating the water end with a jet of steam and then running the pump at reduced speed. When the water end becomes steambound, it is a sure indication that the pump is run too fast, or that the hot water should be supplied under greater head, by placing the pump at lower elevation, or the hot-water supply at greater elevation. A temporary remedy for a steambound water cylinder is to cool the cylinder by spraying with cold water.

Difference Between Double-Acting and Duplex Pump

What is the difference between a double-acting pump and a duplex pump? H. B.

A single-acting pump cylinder is one in which the suction water is received in one end of the cylinder and consequently on only one side of a piston or one end of a plunger. When suction occurs alternately on opposite sides of a water piston, the pump is a double-acting piston pump. When suction occurs on opposite ends of a centrally packed plunger or alternately on the ends of two plungers, both of which are connected to the same rod or yoke, the pump is a double-acting plunger pump. When two single-acting water pistons or plungers are used in the same pumping machine, the assemblage is designated as duplex single-acting, and three or four such pistons or plungers would be designated triplex or quadruplex single-acting, as the case might be. When the assemblage is, in effect, two double-acting pistons or double-acting plunger pumps, it is designated duplex double-acting, that is, there are four suction and four discharge strokes per cycle or revolution. Ordinary direct steam-driven boiler-feed pumps generally are single double-acting or duplex double-acting.

When operated by one steam cylinder, they are single direct double-acting steam piston pumps or single direct double-acting plunger pumps and are commonly designated single direct steam pumps, and when the steam and water cylinders are in duplicate, they are duplex direct double-acting steam piston or plunger pumps and are commonly designated "duplex direct steam pumps."

Tramming Setting of D Slide Valve

How can marks be located to determine whether there is any change in setting of a D slide valve without removing the steam-chest cover? R. L. B.

Before locating any marks it should be ascertained that the valve setting is satisfactory. Before examining the setting prepare a tram *T*, shown in Figs. 1 and 2, made of a piece of heavy steel wire with ends bent over square and pointed. Make the distance between the points any convenient value, although an easily remembered value should be chosen such as four or six inches, so that in case the tram is lost, the distance will be remembered, and if a set of figures is at hand, the tram length point to point should be marked on the rod.

Remove the steam-chest cover and see if the valve is set with the desired leads at each end. For that purpose place the crank on the head-end dead center and measure the lead *H*, Fig. 1; then turn the engine for-

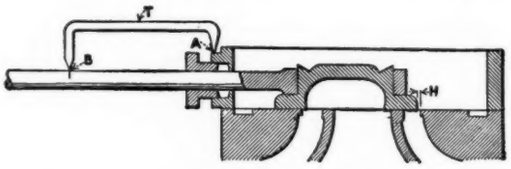


Fig. 1—Tramming with engine on head-end dead center

ward to the crank-end dead center and measure the lead *C*, Fig. 2, in the same manner. On account of the angularity of the connecting rod, equal laps at each end of the valve result in later cutoff for the head end when the valve is set with equal leads, and to favor equalization of the cutoff the lead of the head end must be less than that of the crank end. However, equalization of the leads is of greater importance than equalization of the cutoffs.

If the leads are found to be unequal, they should be made equal by adjusting the length of the eccentric rod or of the valve rod. When they have been made the same, place the crank on the head-end dead center and set the eccentric to that position, when turned in

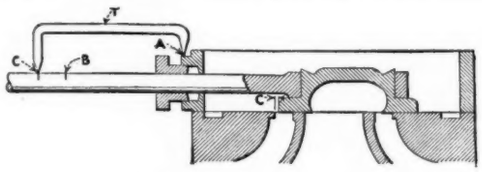


Fig. 2—Tramming with engine on crank-end dead center

forward direction around the shaft, that will give the least amount of desired lead *H*, Fig. 1, for the head end; then turn the engine forward to the crank-end dead center and observe whether proper lead *C*, Fig. 2, is obtained for the crank end.

When the leads are satisfactory, make a mark on the side of the eccentric and a corresponding mark on the shaft to indicate the proper setting of the eccentric. Then with the engine on the head-end dead center, make a spot mark or a prick-punch hole, as at *A*, Fig. 1, on top of the stuffing box, and with one point of the tram at this point scribe a mark *B* on the valve stem and prick-punch the mark. Now turn the engine to the crank-end dead center and make another tram and prick punch and mark *C*, Fig. 2. With the position of the valve rod so marked, it may be disconnected and properly replaced at any time without resetting the valve by observing that the eccentric is in the marked position and the connections with the eccentric rod or valve rod are of proper lengths for correct registration of the tram marks when the crank is placed on either dead center.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication, and for the inquiries to receive attention.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

Can Air Carry Moisture?

CAN air carry moisture? It seems like a foolish question. Is it not a matter of common everyday observation that air carries moisture? Does not the "sweat" on the outside of a cold pipe or a pitcher of ice water come from the moisture carried by the air?

In spite of all the apparent evidence to the contrary, it is doubtful whether air can *carry* moisture, using the word carry in its precise meaning. We know that air is commonly found *mixed* with water vapor, just as in a crowd of people blondes are mixed with brunettes. But no one would say that the blondes *carried* the brunettes or vice versa.

This distinction may seem rather fine and of about as much practical importance as the arguments designed to prove that the tree goes round the squirrel when the squirrel goes round the tree. Yet as a matter of fact, a clear understanding of this point is of practical importance. The commonly held notion that air soaks up moisture as a sponge soaks up water has led to many false conclusions in such practical matters as the drying of moist products and the condensation of moisture from flue gas. Consideration of a few demonstrable facts will show that the sponge analogy, like the sponge itself, is full of holes.

It is an observed fact that at a given temperature a given space will hold a definite weight of water vapor regardless of the amount of air present. For example, at a temperature of 180 deg. F. one cubic foot of volume can hold 0.01994 lb. of water vapor regardless of the weight of air present. If a little water is poured on the bottom of a container of 1 cu.ft. capacity from which all the air has been removed, and if the temperature of the water and container is maintained at 180 deg., just 0.01994 lb. of water will evaporate. If the space contained air at high or low pressure, there would be no change in the weight of water evaporated.

How can the air be said to act as a sponge when it makes not the slightest difference how much air is present? Certainly, a big sponge will hold more water than a small one or no sponge at all. The figure 0.01994 was taken directly from the steam tables and is merely the weight of 1 cu.ft. of saturated water vapor at 180 degrees.

We speak of air saturated with water vapor. What we mean is air mixed with saturated water vapor—that is all.

Now why does it make no difference how much air is present? If the air does not really "soak up" moisture, why does it not do the reverse and cut down the amount of moisture by taking up good space.

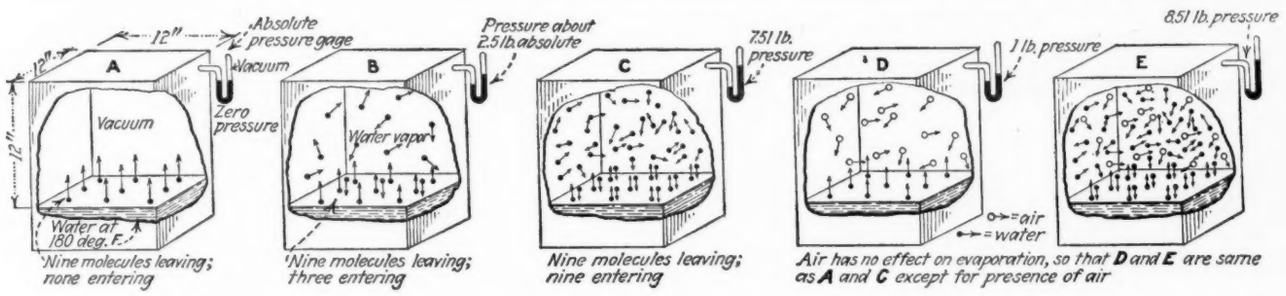
It must first be remembered that gases and vapors are mostly holes. They "inhabit" spaces as men inhabit houses, but they do not really *fill* the spaces in which they are confined.

The diagrammatic sketches *A*, *B* and *C* picture the process of saturating a *space* with water vapor. The water and container, in the case shown, are maintained at 180 deg. and the 1-cu.ft. space above the water is assumed to be a complete vacuum at the start. Now, molecules of water or any other substance are always in motion—the higher the temperature the more rapid the motion. In the liquid state the molecules are so close together that they have considerable attraction for one another. Yet some approach the surface of the liquid with sufficient velocity to break loose as free molecules of vapor which continue to bounce around in the container like balls on a billiard table. The number breaking loose per square foot of liquid surface per second will depend only on the temperature. The higher the temperature the more will break loose.

Take an infinitesimal unit of time so small that nine molecules break loose per square foot in each such unit as shown at *A*. At the start all are leaving—none returning. Gradually, the space above fills up with vapor molecules. At the moment pictured in *B* nine are still leaving per time unit, but three are returning, giving a net evaporation of 6 molecules.

Finally, enough vapor molecules are present above the liquid to keep nine plunging back into the water for every nine that leave, as shown at *C*. In other words, a state has been reached where condensation exactly equals evaporation, so that apparent or net evaporation ceases. Everything is now in balance and the vapor is said to be saturated. For a given water temperature this will occur when the vapor contains a definite number of molecules per cubic foot. This means a definite weight per cubic foot (vapor density). With definite weight and definite temperature (hence definite velocity), the pounding of the molecules on the walls of the container must also produce a definite pressure, called the vapor pressure. For a given temperature of 180 deg. the vapor density will be 0.01994 lb. per cubic foot and the vapor pressure 7.51 lb. (absolute) per square inch. The Marks and Davis steam tables give similar data for other temperatures.

That the presence of air has no effect on either vapor density or vapor pressure is shown at *D* and *E*. Suppose 0.00422 lb. of air per cubic foot is present at the start. It will produce a pressure of 1 lb. per sq.in. The air molecules will continually strike the water, but can neither enter the water themselves nor affect the water molecules leaving or entering. So nine water molecules will leave in each unit of time and the amount of vapor will increase until there is 0.01994 lb. of vapor per cubic foot, which will be sufficient to return nine molecules to the water in each unit of time. This amount of vapor will produce a pressure of 7.51 lb. per sq.in., which will be automatically added to that due to the air, so that the gage will read 7.51 + 1 = 8.51 lb. per sq.in. Vapor and gas pressures always add up in this way. A later article will show some of the practical applications of the principle here illustrated.



Illustrating the principle that the weight of vapor a given space can contain depends only on the temperature and is not affected by the presence or absence of air

New and Improved Equipment

Republic Electric Level and Pressure Gage

A new electrical level and pressure gage has been developed by the Republic Flow Meters Co., of Chicago, which has a great diversity of application, such as giving the head- and tail-water levels in reservoirs, levels in water and oil supply tanks of all kinds, soap vats, etc. The meter may be applied also to giving the height of water in standpipes, to long-distance gas-pressure signaling, to blast-furnace pressures, to the control of the level of liquids in tanks and to other applications.

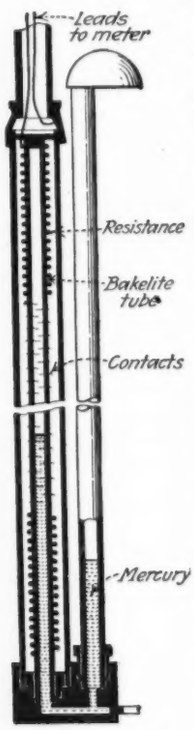


Diagram showing construction of gage body

The meter is designed for all measurements from 6 in. of water pressure up. The complete installation consists of the actuating mechanism or gage body, shown in sectional elevation in the illustration, which, with the variations in head pressure, cuts in or out resistance to give like fluctuations in electrical current. The current is read on electrical instruments of the indicating and recording types, similar to those used with other Republic meters, the scale being calibrated for the specific use to which the meter is to be applied.

In the illustration the gage body is shown to consist of a U-tube containing mercury with one side open to the static pressure to be measured and the other side open to the atmosphere. The pressure of the water, gas or other fluid on the level of the mercury raises the column in the atmospheric side until a balance is established. This rise of mercury cuts out resistance in the internal resistance element and alters the current flow through the meter in proportion to the head, the measurement being made through the instruments which indicate and record in accordance with the current that is flowing.

As indicated in the drawing, the resistance element consists of a tube of bakelite having contact rods extending across the cylinder bore. As the mercury rises, it makes electrical contact with the successive rods. Around the ends of the tube is wound the resistance, and leads are taken from the proper points to the various contact rods.

Where it is desired to maintain levels between definite limits, provision is made to start and stop the pump automatically. When the level drops below a definite specified point, a contact is made causing the controller to start the pump in operation. When the level reaches the maximum desired, the contact is broken and the pump stopped. Thus the pump may be operated at intervals as wide apart and for as long periods as may be desirable to conform with the requirements and minimize the starting and stopping operations.

Universal Coal Spreader

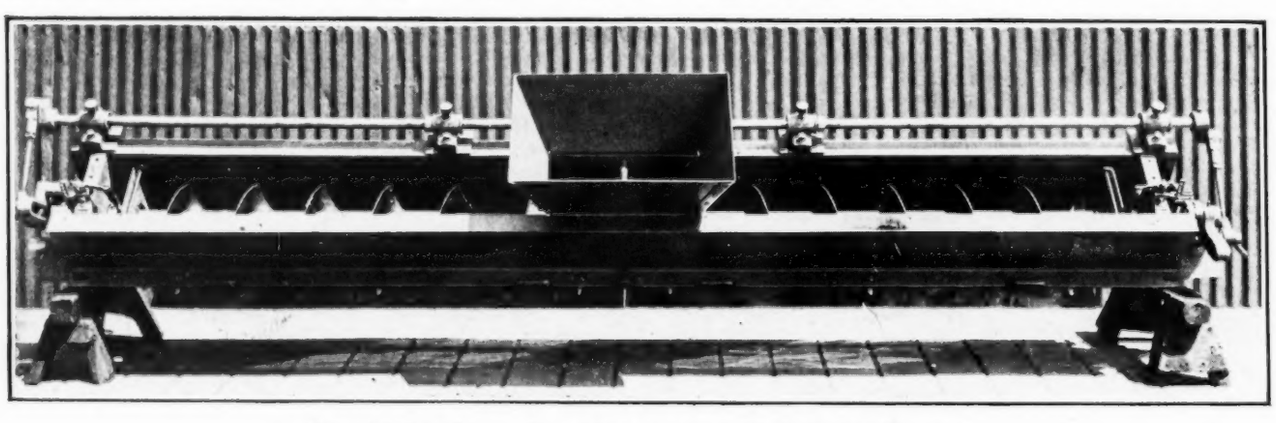
To overcome the tendency to uneven distribution from both ends of its spiral-screw coal spreader, as described in the Aug. 14, 1923, issue, when there is variation in the physical characteristics of the fuel, the Universal Coal Spreader Co., of Chicago, has made certain modifications that have resulted in improved operation. The device is now split at the center and a drive at both ends replaces the single, end drive formerly used, so that each half of the spreader operates as an individual unit with its own drive and control mechanism.

A countershaft running the full length of the spreader is driven from the stoker drive with the intervening transmission of the type best suited to the individual case. At either end is a crank with a connecting rod to the arm of the ratchet driving the screw. These cranks are set 180 deg. apart, so that one ratchet is on the power stroke while the other is on the return stroke. Therefore only half of the coal spreader is being rotated at any one time.

Operation of each screw is controlled by a pressure plate at the end of the hopper, with link connection to a cam on the ratchet wheel. When the hopper is full of coal, the pressure on the plate pushes the cam under the ratchet pawl, preventing engagement with the teeth of the ratchet until the coal begins to recede and the pressure on the plate is relieved.

To prevent damage to the spreader from foreign substances, a shear pin has been located in the drive. Formerly, the shear pin secured the ratchet wheel to a hub keyed to the shaft. With this arrangement the shearing of the pin gave no visual indication of inoperation except lack of coal in the hopper. The ratchet wheel is now keyed directly to the shaft and the shear pin placed in the upper drive knuckle of the connecting rod. The knuckle is split and held together by the pin. When the pin shears, the connecting rod drops out at the upper end and directs immediate attention to the spreader.

Cast iron has been substituted for steel in the flights of the two screws, and where the material is particularly abrasive, such as coke braize, the flights will be made of white iron to withstand the wear.



Remodeled coal spreader, split at center, with drive at either end

Phoenix Self-Cleaning Air Filters Using Oil Film

An automatic constant-effect movable-screen filter using a viscous film to collect the dust and thus cleanse the air, has been acquired by Drying Systems, Inc., of Chicago, from the European designers. The apparatus consists of a built-up screen, suspended vertically, which is mounted on revolving drums and is intermittently moved through an oil bath in which the lower supporting drum revolves. This operation cleans the soiled area of the screen and renews the oil film upon which the effectiveness of the filter depends.

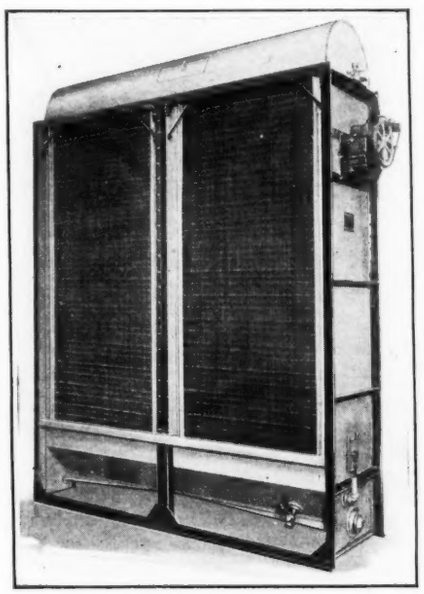


Fig. 1—Phœnix air filter

The screen is composed of a multitude of small plates secured in position by cross-rods. These plates are dieformed, being crisscrossed by depressions and ridges so designed that in every position of the adjacent rows tortuous paths for the air are formed. By means of a fan the air is drawn through this screen and is forced to follow the paths formed by the indentations in the plates.

The viscous fluid used is non-volatile at ordinary temperatures and has a flash point of 385 deg. F. It has a viscosity about seven times that of water, which is sufficiently high to maintain a uniform film over the surfaces of the screen and prevent entrainment of the oil in the air stream. It is claimed that the dust particles collected from the air are held entirely in the viscous film and do not adhere to the surfaces of the screen. Thus, when the dust-laden film is immersed in the fluid bath, the film is destroyed and the dust particles, being heavier than the liquid, settle to the bottom, leaving the surface of the screen plates clean, so that they may carry up a fresh film of oil. After a period of time the sediment trough in the bottom of the reservoir will become filled and require cleaning by draining off the fluid and flushing the trough with a clean liquid, kerosene or soda mixture.

The filter is made either single or double pass as desired. In the single-pass filter the air is drawn into the space between the two vertically suspended portions of the screen and from this space enters the fan, having passed through the screen but once. This type is adequate for ordinary requirements, and a unit of given size has nearly twice the capacity single-pass that it would have double-pass. The double-pass filter is used where extreme cleanliness is essential or where the dust content is unusually great. In this type the air is drawn through the two vertical sections of the screen successively, entering at one side of the unit and leaving from the opposite side.

These filters are made in a variety of sizes in single- or double-section units in the single- and double-pass types, having capacities ranging from 2,200 to 50,000 cu.ft. per minute. As illustrated in the accompanying drawing, Fig. 2, the unit can be supplied with a steel frame to be anchored to the building construction, where this is desirable, such as an installation for cleaning the cooling air for generators, or the filter may be set in a self-supporting steel casing, as is usual for general use. In the smaller sizes the screen may be turned by a hand-operated crank, but ordinarily a small motor is used to do the turning and if desirable this turning of the screen can be done automatically by the use of a Torc clock which may be set for one or two periods of two to ten minutes per day, depending upon the requirements.

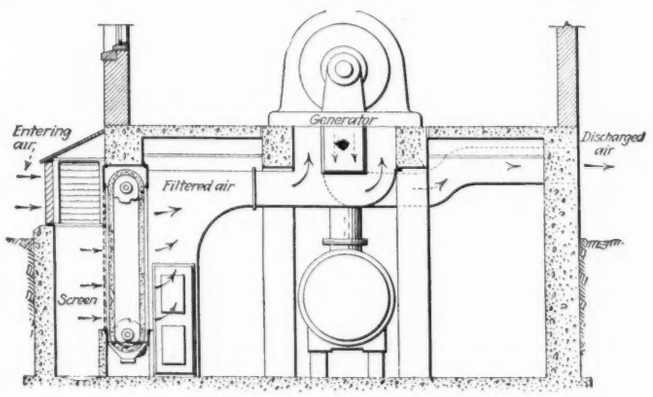
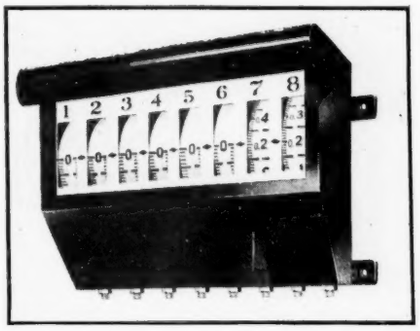


Fig. 2—Typical installation for purifying generator ventilating air

Republic Multiple Draft Indicator

A new type of multiple draft indicator, designed to give any combination from three to twelve units of draft or pressure not exceeding 8 in. of water, has been perfected by the Republic Flow Meters Company, of Chicago. Each unit is built separately, so it is easy to obtain the desired combination. The instrument employs the same mechanical principles as the standard visible-type draft gage made by the same company. That is, it employs a float and balance arrangement, but in one case a pointer revolves on a dial, while in the new instrument a drum bearing the figures is the moving element. The readings are spaced over an arc of 320 deg. on the periphery of the drum, giving the wide divisions indicated in the illustration. Each drum has a permanent zero setting. The readings are flush with the pointers on the face, so that they may be read from any angle, and all readings are at the same eye level. The case is dustproof and is arranged to be bracketed to the boiler front or panel. Illumination is provided in a reflector just above the face to improve the visibility.



New Republic Multiple Draft Indicator

The instrument is operated by a simple lever and gear mechanism actuated by a float, each float being sealed by non-evaporating oil. The float is balanced by an adjustable weight on the opposite arm. A pendulum weight in the form of an arm with a gear segment causes the balance to return to a definite zero position. A draft or pressure causes the float or bell, which is sealed with oil to form a gas holder, to fall or rise as the case may be, the suction or pressure being transmitted to the float through ¼-in. piping. This causes the balance and thus the gear arm to move, with a consequent rotation of the drum. Accurate adjustment is made so that the drum turns off exactly the number of units corresponding to the change in draft or pressure. As a balanced condition is maintained, the instrument is sensitive to draft changes. By varying the counterweight or changing the size of the float, the same mechanism can be used for different drafts and pressures. Magnetic damping is employed to stabilize the drum movement and to give an exact reading of the draft at any instant.

Determining the Quality of Leather Belting*

BELTING leather, as everyone knows, is made from the hide of beef cattle, preferably the steer, this hide being a fibrous covering provided by nature for the protection of the animal. It is composed of an inner membrane which lies next to the flesh, and an outer layer of finer fiber in which the hair is embedded, and between this inner layer of membrane and outer layer of fiber are millions of little fibers, varying in length on different parts of the animal, but all attached either to the membrane or to the outer fiber and to each other, forming a mat or felt of fibers, which in motion work on one another, and which possess great strength. In the process of tanning this fibrous material is changed into a wonderfully strong and flexible substance which is not affected by the ordinary solvents of nature (air, water, etc.) or by fungous or bacterial influences.

Over the backbone of the animal the fibers are shorter and denser, of slightly less tensile strength and less stretch, but they change in their nature as we proceed down the side of the animal from the backbone, and about halfway down we find the fibers longer and not so dense, and stronger, and farther toward the belly of the animal they are still longer, with a higher tensile strength, but with more stretch and less elasticity. It is desirable, therefore, that belts should be made of the upper half of the side of the animal, and this constitutes, roughly, according to the size of the animal, a strip equivalent to about fifteen inches each side of the backbone. In the examination of belting the question therefore becomes important whether the belt is made of that portion above this line, drawn 15 in. from the backbone, or whether

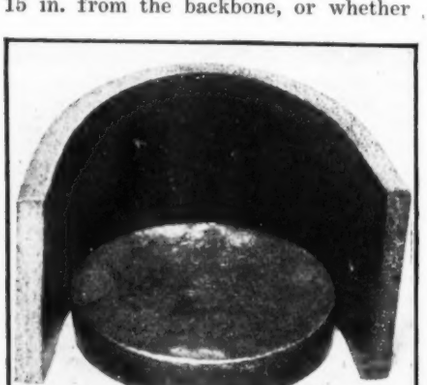


Fig. 1—Showing good leather, which does not "pipe" when bent over a 2-in. form.

it is made of that portion lying farther down.

This can be determined with a reasonable degree of accuracy by the "piping" test. This is based on the fact that the leather in the lower half of the hide, with its longer and looser fibers, is softer and spongier than the upper part, and that the grain surface of the leather is not so firmly attached to the inner fiber, and in bending this leather it will develop usually into wrinkles or "pipes" in the grain. It is possible to produce "pipes" in almost any piece of leather by bending it often enough and close enough and applying sufficient force, but to make the test perfectly fair the specifications provide that a single leather belt shall not show pipes, or piping, when bent over a form of 2-in. diameter; or a double belt $\frac{11}{64}$-in. thick when bent over a 4-in. form; or a double belt $\frac{13}{64}$-in. thick when bent over a 6-in. form. Practically all belly stock will show piping under this test, even when it has been rolled hard to prevent it showing, and hence it is

Fig. 2—Showing the badly "piped" grain of poor leather, when bent over a 2-in. form.

not desirable for belting purposes. Occasionally also, pieces from the upper part of the hide will show piping under this test, but regardless of the part of the hide from which the piece is taken, the presence of piping indicates a loose grain and a flabby fiber in the leather, which is not conducive to durability in the belt, and in most cases indicates the presence of belly stock.

Another test is applied by bending the leather over the same form with the grain side outside, to detect cracking in the grain. In this test if minute cracks running across the width of the belt develop, it may be determined that the material either is not properly tanned or is not properly curried, and that it is not suitable for desirable belts.

It is not possible to determine much about the quality of the leather by its "feel," because the makers of these inferior commercial grades have learned the trick of rolling and jacking their leather and filling it with materials to solidify it, that make the "feel" very deceptive, but the piping test described, if properly applied, will expose it.

The tensile strength test is important only in connection with other tests, since the poorest part of the hide shows the greatest tensile strength. Since hides vary so much in substance and strength in their different parts, it is not possible to test one piece of leather and to say that that gives the

Fig. 3—Showing surface, or grain cracks of poor leather when bent over a 2-in. form, grain out.

tensile strength of the belt. The specifications meet this condition by providing that five test specimens shall be selected at random from different parts of the sample being examined, and that these shall average 3,750 lb. per square inch of section, and that the minimum shall be not less than 3,000 lb.

Another requisite of good belting is that it shall be of the proper thickness. Sometimes this is designated by weights per square foot, but care should be taken that the belts offered should measure in thickness, or should weigh, according to the specification of purchase. Medium or regular singles, for instance, should measure from 10/64-in. to 12/64-in.; that is, the narrow sizes, $1\frac{1}{2}$ in. and 2 in., should measure 10/64-in., and the wider sizes, 4-in. to 6-in., should measure 12/64-in. and weigh from 14 to 16 oz. per square foot. This especially is necessary in buying double belts. Care should be taken, also, that the belts shall be accurate in width, and variations in width of more than one per cent are not tolerable.

Belts must be purchased for their substantiality, but a belt may be made of very excellent leather and still be inefficient as a transmitter of power, because the latter quality depends almost entirely on the treatment that has been given the grain or hair side. Many buyers think that if the belt feels firm and solid and is highly finished, it must be leather of a high quality, but this is a mistake. The firmest and most solid leather is attained by heavy rolling and jacking, and the high polish by jacking; both are destructive of the fibrous grain surface. The contact of the belt with the pulley is formed by this elastic cushion of the natural grain, and when this is destroyed by mechanical action, the capacity for making this close pulley contact is much reduced, and under test the rolled and jacked leather transmits little more than half as much power as that with a natural finish.

*Excerpts from a report just released by Louis Arny, secretary of the Leather Belting Exchange.

News in the Field of Power

Lewis River Development Planned

According to press reports plans for a large water-power development in south-western Washington are under way. Eight appropriation filings and four reservoir sites on the Lewis River have been asked by H. L. Gilbert, of Portland, Ore., with the declared intention of developing 90,350 hp. at an expenditure of $11,955,000 in its development.

Baltimore To Have Lower Electric Rate

The Consolidated Gas, Electric Light & Power Co. of Baltimore announced on Sept. 23, a reduction of electric rates of more than 10 per cent, to some 90,000 consumers, to become effective on Nov. 1. According to H. A. Wagner, president, the new rates will represent a reduction for Nov. and Dec. of $82,000 and $875,000 for the next year. For two months of the current year and all of next the cut will mean a saving to customers of $1,000,000.

Attitude of Upper Colorado River States Criticized

Much criticism of the states of the upper Colorado River basin is heard in official quarters in Washington because of the formal action taken in opposition to the extension of any rights on the Colorado River until the compact has been made effective.

There has been little sympathy in Washington for the attitude of Arizona in refusing to sign the compact, but the feeling is that there is even less to be said in justification of this action of the upper states.

Large Power Development Planned for Mexico

Plans for electrification of territory along the west coast of Mexico, are well advanced, according to press reports. Surveys for proposed dams and power transmission lines have been finished and everything is now in readiness for the awarding of contracts.

This is the situation so far as the project of the interests that own the United Sugar Co. of Los Mochis is concerned. The project involves construction of a dam across the Fuerte River, near the Sinaloa-Chihuahua boundary, and construction of a hydro-electric plant and system of power transmission lines, extending to remote mining camps in Chihuahua.

In addition to providing an enormous amount of electric power, the project of the United Sugar Co. interests will store water sufficient to irrigate about 400,000 acres of land in the Fuerte River Valley, it is stated. It is estimated that the cost of the proposed works will be approximately $10,000,000, United States money.

Japan Buying Generating Equipment

There is a marked activity in the electrical-equipment business in Japan, and the contracts for a considerable number of power generators, units, dome switchgear and railway motors are pending, according to a cable to the Department of Commerce from Acting Commercial Attaché A. Bland Calder, Tokyo. English competition is increasing, the Metropolitan-Vickers Co. having obtained orders for more than 100,000 kw. of generating equipment during the month of August.

Pennsylvania, Ohio, Minnesota Protest Chicago's Diversion

Pennsylvania, Ohio and Minnesota on Oct. 5 will ask the United States Supreme Court to be made parties plaintiff to the suit brought by Wisconsin against Illinois and the Chicago Sanitary District to stop diversion of the waters of Lake Michigan into the Chicago drainage canal, according to Attorney General Crabbe.

The petition recites the interest which the various states have in maintaining a proper level for the Great Lakes as an aid to commerce, saying that free navigation on the lakes is imperiled by diversion of their waters and subsequent lowering of the lake levels.

Diversion at Niagara Falls Complies with Treaty

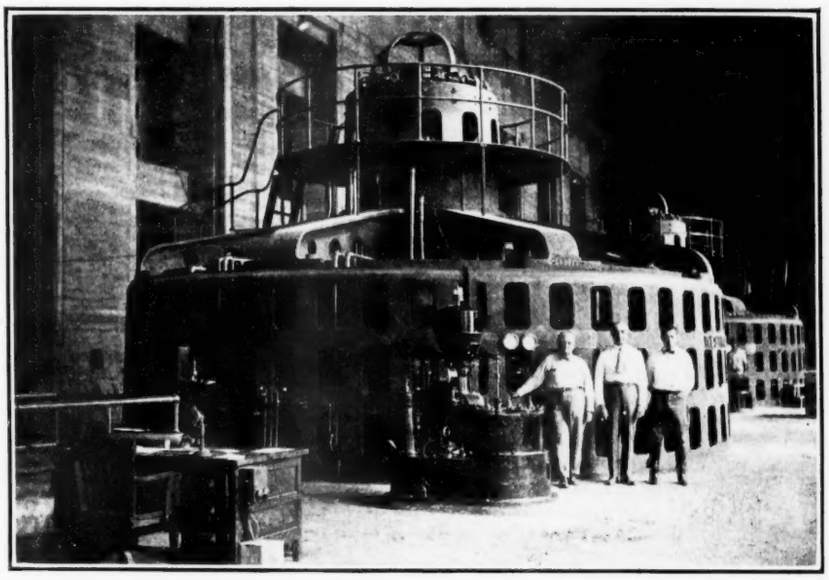
The Report of the Niagara Control Board, covering work performed by the Board in connection with the diversion of water from the Niagara River for power purposes, dated June 15, 1925, was released on Sept. 19 by the Department of State.

The report states: "Since Jan. 2, 1925, hourly measurements have been made at the power plants on both sides of the Niagara River at Niagara Falls, and show that all the power plants have been and are being operated in entire compliance with the provisions of the treaty. These records are on file at the Dominion Water Power and Reclamation Service of the Department of the Interior, Ottawa, Canada, and at the United States Engineers Office, 540 Federal Building, Buffalo, N. Y."

The treaty was enacted to prevent the exploitation of the Niagara River by industries, thus destroying the scenic beauty of the falls.

The report further states: "It is pertinent to refer here to the fact that while hydraulic installation on both sides of the boundary is now such that it is physically possible to divert water in excess of the treaty limitations, the policy pursued in both countries has been that of partial closure of the older and more inefficient plants and the utilization of the water in the new and highly efficient plants."

The Control Board is composed of J. T. Johnston, Canadian representative, and Major Paul S. Reinecke, of the U. S. Army Corps of Engineers.



Generator No. 2 at Muscle Shoals at moment when first power at Wilson Dam was started in the distribution. Left to right are: Hugh L. Cooper, Maj. Gen. H. L. Taylor and Maj. Max Tyler

Survey of Water Resources by Geological Survey Meets Opposition

This Plan Sponsored by American Engineering Council Is To Be Introduced at Forthcoming Congress

LEGISLATION proposing a national survey of water resources by the United States Geological Survey, sponsored by the American Engineering Council, will be opposed vigorously by the Corps of Engineers of the Army, by the staff of the Federal Power Commission and by many friends of the Water Power Act.

The Water Power Act set up the Federal Power Commission as the agency to bring into co-ordination the agencies of all the government departments dealing with water power. The Geological Survey, it is contended, has no legislative authority to deal with navigation, flood control, irrigation, or forest development. Thus far the work of the Geological Survey has been confined largely to stream gaging and the collection of data as to the underground water supplies. It has not had experience, it is declared, in developing plans for the use of water in connection with navigation, irrigation, flood control or forest development.

To put the general survey in the hands of one of the agencies handling water problems to the exclusion of the other agencies would be contrary to the spirit of the water power act, those in opposition to the proposal state.

The need for a survey of the resources of the important streams of the country long has been recognized. It has been the subject of discussion in Congress for years. The late Senator Newlands, of Nevada, championed a very ambitious program of this kind. It involved such expense and such exhaustive study that it made but little progress. In 1917 a commission was authorized to make a modified study of rivers. Because of the exigencies of the war period the President declined to appoint the commission. The authority to create the board was repealed by the Water Power Act on the ground that it provided for just such studies.

The Water Power Act specified that the license fees from projects may be devoted to such studies but enabling legislation is needed before these funds can be expended. Thus far they have been turned back to the Treasury. License fees now are being collected at the rate of $250,000 annually and will increase at the rate of $50,000 annually. To this could be added the receipts from the rental of government dams and other structures. The proposal to have the surveys made under the Water Power Act is expected to appeal to Congress as no money will have to be taken from the Treasury for the purpose. Another argument is that the government is under moral obligation to its licensees to expend the money in some such way rather than allow it to be covered into the Treasury as miscellaneous receipts, as at present.

An effort to get the enabling legislation at the last session of Congress failed, but the Corps of Engineers and the Federal Power Commission were ordered to report jointly on the scope of the proposed river surveys and their probable cost. This report is now in preparation. When it is presented to Congress in December it probably will be accompanied by a recommendation as to the form of legislation on which the Federal Power Commission and the Corps of Engineers probably will agree.

St. Lawrence River Plans of Ontario Outlined

A report just issued by the Ontario Hydro-Electric Power Commission gives details of three alternative proposals it has in mind for the improvement of the international stretch of the St. Lawrence River for navigation and for the development of 1,600,000 hp. of electric power. One project contemplates all the power being developed at the foot of the Long Sault; another contemplates the generation of part of the power near Morrisburg, Ontario, and the third is similar to the second, but with the upper power house situated at Crysler Island. While the documentary character of the original 1921 report, with its plans and estimates of costs, its discussion of relative flooding and other advantages and disadvantages and its treatment of the economies of the project, is carefully preserved in the present report, the commission has added material that brings up to date such figures as power supply statistics, total investments in plant for supply of electricity to Ontario municipalities and other matters.

Of special interest is a comment that amplifies the discussion of the market for the disposal of the 800,000 potential St. Lawrence horsepower owned by the Province of Ontario. The commission reports that, in view of the rapidity with which the output of the Queenston-Chippawa development has been absorbed by the Niagara system, the St. Lawrence development will serve an area with a population of two and one-half million people in Ontario, instead of a substantially smaller population, as was provisionally assumed in 1921, when uncertainty with respect to the probable course of electrical demands after the war was felt. The report states:

"The commission in its report as submitted in 1921 assumed that an increase in per capita consumption per annum of 33 per cent would take place in the ten-year period from 1921 to 1931. Recent records issued by the Bureau of Statistics indicate that this percentage increase of per capita consumption per annum in the Province of Ontario was attained in about two years. At present the judgment of the commission is that it will be necessary to provide new sources of electric power amounting to more than 400,000 hp. by 1931, which would be increased to over 1,100,000 hp. in 1936. Viewing the future power markets in the light of present information, it may be stated that if authority were immediately granted to develop the international portion of the St. Lawrence, by 1935 or 1936 the whole of Ontario's share of the St. Lawrence River power would probably be absorbed by the Ontario markets alone."

Quoddy Project Interests Engineers

William S. Murray, consulting engineer, who has been conducting a detailed investigation of the Passamoquoddy tidal power scheme, described in Aug. 25 *Power*, page 309, indorses the project as being practical and economically advantageous, in an interview given to the press recently. The project, he said, would probably result in the formation of a huge electrical system covering New England and perhaps extending much farther.

New England Power Merger Report Still Unconfirmed

Reports in the newspapers of a week ago and which are still unconfirmed at the time this is written, state that there is to be a union in the future between the Power Corporation of New York, which has its headquarters at Watertown, N. Y.; the New England Power Co., with headquarters at Worcester, Mass., and the International Paper Co., all controlling extensive hydro-electric plants in New York State or the New England commonwealths. The newly organized Mohawk-Hudson Power Co., in which the Power Corporation of New York has a considerable interest, is also included in the story. Such a community of interests would tie together electric properties extending across the northern part of New York south to Albany and into Massachusetts, Vermont, New Hampshire, Connecticut and Rhode Island.

New Power Plant To Be Built at Melones Dam

Approval was given by the California Railroad Commission recently to an agreement between the Pacific Gas & Electric Co. and its leased subsidiary, the Sierra & San Francisco Power Co., on the one hand, and the Oakdale and South San Joaquin Irrigation Districts, on the other hand, under which the power corporations will build a plant containing two units of 13,500 kva. capacity each below the Melones Dam at a cost of $2,530,000 and transmission lines to Copperopolis and Manteca at a cost of $158,000. The power companies are to pay the irrigation districts $5,175,000 in semi-annual installments of $64,680.50, payable Dec. 15 and June 15 of each year. Until the entire amount of $5,175,000 has been paid by the power corporations, the districts are to bear the cost of maintaining Melones Dam and reservoir. Upon the completion of such payment the power corporations are to bear one-half this cost.

Joint Board Investigations of St. Lawrence

Every effort is being made by the Joint Board of Engineers to complete the investigations along the St. Lawrence during this field season. The very favorable season has brought within the range of probability what had appeared at first to be impossible. By requiring the engineers' report by April a very difficult task was prescribed. The chances now seem to favor the completion of the report on time.

The section of the river from Messina to Cornwall has been depicted in a large-scale relief model, which just has been completed. This model is now being shown at the Corps of Engineers in Washington, but will be sent to Detroit in the near future, where there is greater use for it.

Yuba River Applications Conflict

The application of the Nevada Irrigation District for power rights on the Yuba River was reconsidered by the Federal Power Commission on Sept. 21. This application was in conflict with one of the Yuba River Power Co.; the Excelsior Water Power Co. having withdrawn a third conflicting project.

After discussion it was apparent that the Commission was not entirely convinced that the irrigation district would use the water for anything other than the generation of power. Had the irrigation district been able to establish that the water is essential to a feasible irrigation project, with power development an incident to that use, no difficulty would be had in reaching a decision. As the matter stands the Commission is in doubt and feels that it must discharge the responsibility vested in it to approve only the most efficient use of water resources.

Every effort will be made to hand down a final decision in this case by Oct. 1.

Leather belting imports into China aggregated $532,897 in 1924, according to the Chinese Maritime Customs. Great Britain and the United States, the leading sources of supply, shared almost equally in the trade, the respective shipments from each country having been $237,099 and $213,884. Germany, supplying $49,521 worth, and Japan, supplying $24,323 worth, were the only other countries of any importance in the trade.—*Commerce Reports.*

The Bangor (Maine) Hydro-Electric Power Co., through Edward M. Graham, purchased on Sept. 10 the entire property of the Pannamaquan Power Co., of Eastport, from Edwin B. Jonah and associates. Leroy H. Vose, superintendent for the last 12 years, has been retained as local manager.

The Puget Sound Power & Light Co. has offered the city of Ellensburg, Wash., $275,000 for its municipal power plant, which the company could operate by the extension of its Wenatchee lines.

New Miami Fort Station Name Changed to Columbia

President Gossler of the Columbia Gas & Electric Co. announces that the name of the Miami Fort power station will hereafter be known as the Columbia power station. The name of the settlement which has been referred to heretofore as Miami Fort is now Columbia, Ohio. The date for the formal opening of this new station has been set for Nov. 12.

Sir Charles Parsons To Build Turbine Steamer

According to recent announcements in the press the Parsons Turbine Co. is to build, in association with the William Denny & Brothers at Dumbarton, a turbine steamer. This ship will have water-tube boilers working at a pressure of nearly 550 lb. to the square inch. Use of the latest inventions for economical steam raising will be embodied, including the preheating of air, and oil-fired boilers. The auxiliary machinery will be worked by low-pressure steam, tapped from one of the expansion stages of the turbine for this purpose. The ship, which is to be driven by twin screws, will, when completed next spring, be employed on the passenger day service on the Clyde.

American Brown Boveri Co. To Be Organized

Laurence R. Wilder, president of the Wilder Electric Trusts, Ltd., who will be president of the new American Brown Boveri Co., to be organized as the American branch of the Swiss Brown, Boveri & Co., Ltd., of Baden, announced on his return from Switzerland that the Swiss company had ratified the plan announced by P. A. S. Franklin, chairman of the board of the New York Shipbuilding Corp., providing for the acquisition of the ship corporation by the American Brown Boveri Co. The company's plans are for the creation of "the third great electrical manufacturing company in this country," employing the Swiss company's patents and rights of manufacture in the production of electrical equipment here. The capital set-up of the company is expected to be announced shortly.

As a result of the ratification of the ship corporation deal, Mr. Wilder said everything was in readiness to go ahead with the formation of the American Brown Boveri Co. He added:

"The new American Brown Boveri Co. will be built around the present capital structure of the New York Shipbuilding Corp. Founders' shares of this company will be owned by Brown, Boveri & Co. of Switzerland, and a public offering will be made at an early date of participating shares of the American company. The prospects of the new American company are excellent in view of the fact that the public utilities of this country are spending about $1,000,000,000 annually."

Marvin A. Neeland, president of the New York Shipbuilding Corp., who returned with Mr. Wilder, said that he was astonished, after study of the Brown, Boveri Co.'s plant, to realize how readily the plant of the New York Shipbuilding Corp. would lend itself to the manufacturing of electrical equipment without interfering with its present shipbuilding operations, which will continue as before.

Columbia River Basin Project Is Premature

In a report submitted to the Secretary of the Interior recently by the special commission studying the proposed Columbia River Basin reclamation project in the State of Washington, connected with which were plans for the development of considerable power, it was declared that the time had not arrived when local and national interests required its construction.

Lockport $16 Power Rate Upheld by Court

Supreme Court Justice Lytle handed down a decision today in the Lockport "$16 power rate case," which is regarded as a victory for the city. The decision was in the suit brought by the Lockport Paper Co., the Niagara Paper Co. and others to prevent ratification of a proposed 15-year power agreement between the city and the Niagara, Lockport & Ontario Power Co. and associated companies.

The case has been in litigation for several years. Last year the city and the power interests reached an agreement and the Court held this agreement to be valid. It provides that the power company supply 20,000 hp. at $16 per horsepower.

Anthracite Substitute Buying Slack

Outwardly, the anthracite situation is so calm that the man in the street is forgetting that a strike is in progress. Prices of coal are not rising noticeably. The people throughout most of the country's area have been sweltering and have given little thought to the winter. Absolutely no public pressure has been brought to bear on the situation.

It is apparent that federal officials are watching with concern the failure of the public in the anthracite-consuming areas to start the buying of substitutes. Production of soft coal declined during the first week of the anthracite strike. The decline is only partly explained by the Labor Day holiday. It is now apparent that the heavier movement of soft coal in August was not due to the purchase of substitutes, but to the accumulation of larger reserves by the steam trade. Prices of bituminous have reacted only slightly to the strike. The average spot price of the week of Sept. 12 was only fifteen cents a ton higher than that of a year ago. The quarter from which the highest prices have been offered is not New England. It is not from the North Atlantic seaboard, but is from the Middle West, where but little anthracite has been used for some years. Every check that can be made from current statistics indicates that the buying of substitutes has been very limited indeed.

New England Power Companies Bought by Insulls

The Insull interests have formed the New England Public Service Co. to take over and consolidate the Central Maine Power & Light Co., Manchester Traction, Light & Power Co., Twin State Gas & Electric Co., Berwick & Salmon Falls Electric Co., Vermont Hydro-electric Corp., Rutland Railway, Light & Power Co., and the Pittsfield Power Co. Until recently the Insulls, identified chiefly with utility enterprises in the Middle West, were not deeply interested in New England power properties.

The new company will be capitalized with 200,000 shares of no par prior lien preferred stock, 200,000 shares of no par value preferred, and 400,000 shares of common. Samuel Insull, of Chicago, is chairman of the board, and W. S. Wyman, of Augusta, Me., formerly president of the Central Maine Power & Light Co. is to be president of the new holding concern.

American Pulverized Fuel Equipment Popular in Europe

The Fuller-Lehigh Co. announces the closing of a contract through their European representatives — Messrs. Babcock & Wilcox, Ltd., with the Société D'Electricite de Paris for a pulverized fuel installation at the St. Denis station, which will be by far the largest installation of this kind yet made in Europe. The St. Denis station is located just outside of the Paris city limits on the River Seine.

The boiler equipment consists of 8 B. & W. boilers each of 10,760 sq.ft. of heating surface, producing 55 tons maximum of steam per hour each at 315 lb. pressure and 375 deg. Cen. (707 deg. F.) total temperature. The coal used will vary somewhat as to quality, but will have an average heat value of 6,000 calories (10,800 B.t.u. per pound), with about 12 per cent volatile, 20 to 22 per cent of ash and 5 to 10 per cent of moisture, with ash fusion temperature of 1,140 deg. Cen. (2,084 deg. F.)

Other interesting contracts recently placed for Fuller-Lehigh pulverized fuel equipment for boilers include: in Holland, Hague Electricity Works, The Hague, and Rotterdam Electricity Works, Rotterdam; in Germany, Grosskraftwerk of Stettin; in Czechoslovakia, the Witkowitz Steel Works, Witkowitz, and in England, Castner Kellner Alkali Co., Ltd., Runcorn, and the Birmingham University, Birmingham, (commercial scale demonstration plant for University Research Laboratory).

British South Africa Buys Power Machinery

The United States exports of power machinery to British South Africa, according to the *Commerce Reports* for 1922, 1923, and 1924 were as follows:

UNITED STATES EXPORTS OF POWER MACHINERY TO BRITISH SOUTH AFRICA

Class	1922	1923	1924
Power-generating machinery, except electric	$33,414	$68,934	$179,653
Construction and conveying machinery	106,615	127,902	150,740
Mining, oil-well, and pumping machinery	411,312	967,503	1,406,646

N. Y. Water Power Commission Hearings Oct. 5

The New York Water Power Commission at its Sept. 17 meeting fixed the rental charges for the use of the surplus canal waters at the east end of Dam No. 4 in the Oswego River at Fulton, N. Y., at $15,000 per year, and fixed Oct. 5 as the date of a hearing to be held according to law on such determination.

The Commission will take up at this meeting the application of the Lower Niagara River Power & Supply Co. for a project in Niagara Gorge and will also take up the application of the Rochester Gas & Electric Corp. for the use of surplus canal water at Barge Harbor, Rochester.

Civil Engineers Have Program Devoted to Canada's Hydro

The American Society of Civil Engineers, which is to hold its Fall meeting at Montreal, Que., Canada, Oct. 14-16, will have as its main topic Hydro-Electric Development in Canada. Papers of interest to readers will be: "Development by the Hydro-Electric Power Commission of Ontario," by Frederick A. Gaby; "Some Economic Aspects of Hydro-Electric Development in Canada," by Ira W. McConnell; "Hydro-Electric Development in Canada—A Discussion," led by H. G. Acres, N. R. Gibson, William S. Lee, D. W. Mead, Julian C. Smith and Arthur Surveyer. An all-day excursion to power developments on the St. Maurice River will be conducted by Julian C. Smith, vice-president and general manager of the Shawinigan Water & Power Co.

New Steam Plant for Southern Power Co.

A 60,000-kw. steam plant is to be built by the Southern Power Co. immediately in order to create a reserve that will provide ample future assurance against the possibility of power curtailment because of drought. This announcement was made by C. I. Burkholder, vice-president and general manager of the company, after a conference with President J. B. Duke and Chief Engineer W. S. Lee. The exact location of the new plant has not been determined, but it will be on the Catawba River so as to fit in conveniently with other plants of the Southern Power system.

The situation confronting the company was succinctly stated by Mr. Duke as follows: "The first plants of the Southern Power Co. were built in the light of river records available over a long period of years. When the flood of 1916 smashed all previous records, we put our system in shape to meet any possible contingencies of flood conditions. Now with all drought records smashed, we purpose to put the system in shape to meet any possible contingencies of this nature."

The company's 60,000-hp. Rhodhiss plant, near Hickory, which was completed in March, has never been able to operate at more than a small percentage of its capacity because of the drought and the consequent lack of water in the impounding reservoir. If this reservoir had been full when the drought started, it would have afforded great additional reserve power. Another coming resource is the new dam and power station at Fort Mill, S. C., which will provide 80,000 hp. when it is completed. The company now has steam plants at Duncan and Greenville, S. C., and Mount Holly, Greensboro and University Station, N. C. These plants are in operation day and night.

Obituary

F. F. Mesta, president and general manager of the Mesta Machine Co., Pittsburgh, Pa., died suddenly at his home on Aug. 31. He had been recently elected president in the place of his brother George, who died in April. Mr. Mesta received his early education in the public schools of Allegheny County, Pa., and graduated from high school in Leechburg, Pa. His practical experience was obtained in the plant of the Leechburg Foundry & Machine Co., later taking up engineering and entering the engineering department of the firm. In 1898 he took charge of the construction of the present plant at West Homestead, Pa., and was made general superintendent when the plant was put into operation. In 1912 he was made vice-president in charge of operations, which position he held until April, when he became president of the company.

Personal Mention

Clifford F. Stallings is now located at the Birmingham office of the Alabama Power Co.

Howard Tansey, mechanical engineer of the Dayton Power & Light Co. is leaving the company after twenty years of service, to associate himself with F. G. Stroop.

Robert F. Wiselogel has moved from St. Louis to Framingham, Mass., where he has taken up the duties of designer of water-tube boilers with the International Engineering Works.

F. A. Moreland, after five and one-half years of service with the Cokal Stoker Corp. of Chicago, has severed his connections with this company and intends to devote his time to the handling of sales accounts from his address at 4048 North Kostner Ave., Chicago, Ill.

Society Affairs

American Society for Testing Materials has issued its standards for 1925, which is the first supplement to the 1924 Book of Standards. The Standard Specifications for Seamless 70-30 Brass Condenser Tubes and Ferrule Stock and the Standard Specifications for Seamless Muntz Metal Condenser Tubes and Ferrule Stock are included in this supplement.

The Buffalo Section of the A. S. M. E. will hold a meeting at the Hotel Statler on Oct. 20, at which L. W. Wallace, executive secretary of the American Engineering Council, will speak on "Waste in Distribution."

The Indianapolis Section of the A. S. M. E. will hold a joint meeting at the Purdue University, Lafayette, Ind., with all Indiana Student Branches on Oct. 17. Dr. William F. Durand, president of the A. S. M. E., will be the speaker.

The Meriden Section of the A. S. M. E. will hold a dinner meeting at the Y. M. C. A. in conjunction with other local organizations on Oct. 21. L. W. Wallace, executive secretary of the American Engineering Council, will speak on "Waste in Distribution."

The American Chemical Society will hold a discussion on motor fuel and oil conservation during the meetings to be held at Rumford Hall, 52 East 41st St., New York City during the mornings of Sept. 29-30 and Oct. 1. On Tuesday morning the discussion will cover the petroleum situation, Wednesday morning the substitutes for gasoline, and Thursday morning C. F. Kettering of the General Motors Research Corp. will discuss motor design as related to fuel conservation.

Business Notes

The Kuhlman Electric Co., of Bay City, Mich., announces the appointment of the D. H. Braymer Equipment Co., 727 W. O. W. Building, Omaha, Neb., as district representatives in Iowa and Nebraska.

The Universal Coal Spreader Co., Chicago, Ill., announces the appointment of the Pittsburgh Machine Products Co., Oliver Bldg., Pittsburgh, Pa., as sales representative covering western Pennsylvania and Ohio.

The Northern Equipment Co., Erie, Pa., manufacturer of the Copes system of boiler-feed control announces the appointment of Harry H. Leathers, 80 Federal St., Boston, Mass., as its New England representative. H. D. Ruos, 2nd, formerly with the Duquesne Light Co. and the Carnegie Steel Co., has recently joined the inspection engineering staff.

The Electric Controller & Manufacturing Co., 2700 East 79th St., Cleveland, Ohio, announces the appointment of Eicher & Bratt, Seattle, Wash., as its representative for the States of Oregon, Washington, Alaska and the "Pan Handle" district of Idaho. Eicher & Bratt will also represent the Pittsburgh Transformer Co., Jewell Electric Instrument Co. and the Electric Power Equipment Corp.

Trade Catalogs

Stokers—Flynn & Emrich Co., Baltimore, Md. "Five Minutes With the Coal Bill," is the name of a little book catalog containing information in regard to the Huber stoker and its users.

Heaters—Alberger Heater Co., 281 Chicago St., Buffalo, N. Y. Bulletin No. 4 describes water heaters and heat-interchange equipment manufactured by this company.

Coming Conventions

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engnieering Building, New York City, Feb. 8-12, 1926.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Welding Society. M. M. Kelly, 33 W. 29th St., New York City. Fall meeting and Exposition of Welding Equipment and Accessories at the Massachusetts Institute of Technology, Cambridge, Mass., Oct. 21-23.

Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution, Washington, D. C. Annual meeting at Kansas City, Dec. 28, 1925, to Jan. 2, 1926.

Association of Edison Illuminating Companies. Preston S. Miller, 80th St. and East End Ave., New York City. Annual meeting at New Arlington Hotel, Hot Springs, Ark., Oct. 19-23.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Convention at Atlantic City, Nov. 23-25.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30, 1926.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Exposition of Power & Mechanical Engineering. Fred W. Payne and C. F. Roth, Managers, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

Society of Naval Architects and Marine Engineers. Daniel H. Cox, 29 West 39th St., New York City. Convention at the Engineering Building, 29 West 39th St., New York City, Nov. 12-13.

Tachometers—The Brown Instrument Co., Philadelphia, Pa. Catalog No. 44 describes these indicating and recording tachometers for measuring or counting revolutions per minute. It is well illustrated with photos and charts.

Gages—The Brown Instrument Co., Philadelphia, Pa. Catalog No. 74 covers the recording pressure and vacuum gages manufactured by them. The pages are enlivened by drawings and tables.

Compressors—Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa. Bulletin No. 4-F describes with accompanying drawings these steam-jet thermo-compressors and gives dimensions and prices.

Valves—The Edward Valve & Manufacturing Co., East Chicago, Ind. A series of letters, ten in number, dealing with valve construction, installation, maintenance, operation, loss through steam leaks and other power plant subjects, is being mailed at the rate of one every two weeks. This series of letters contains some useful information well worth having and is being mailed upon request.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Sept. 21 1925
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	2.40
Clearfield	Boston	2.25@ 2.80
Somerset	Boston	2.15@ 2.35
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.50@ 1.80
Pittsburgh	Pittsburgh	2.00@ 2.15
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50
Buckwheat No. 1.	Philadelphia	2.50
Birdseye	New York	1.60

FUEL OIL

New York—Sept. 24, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg. 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Sept. 15, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.80 per bbl.; 26@28 deg., $1.85 per bbl.; 28@30 deg., $1.90 per bbl.; 30@32 deg., $1.95 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5.7c. per gal.

Pittsburgh—Sept. 15, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.

Dallas—Sept. 19, f.o.b. local refinery 26@30 deg., $1.65 per bbl.

Philadelphia—Sept. 17, 27@30 deg., $2.15@$2.21 per bbl.; 18@22 deg., $1.848@$1.908; 13@19 deg., $1.575@ $1.635 per bbl.

Boston—Sept. 21, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4.2c. per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati—Sept. 15, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 5¼c. per gal.; 26@30 deg., 5⅝c. per gal.; 30@32 deg., 5⅝c. per gal.

Chicago—Sept. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago 92c. per bbl.; 24@26 deg., $1.10 per bbl.; 30@32 deg., $1.25.

New Plant Construction

Ark., Fayette Junction — J. P. Brower, Fayetteville, is in the market for a 150 or 200 hp. steam boiler and 100 hp. steam engine for woodworking plant here.

Calif., Los Angeles — Tifal & O'Connor, 520 Chamber of Commerce Bldg., has had plans prepared for the construction of a 10 story apartment including steam heating system at 5th and Normandie Sts. Estimated cost $1,000,000. Private plans.

Calif., Santa Monica—Palisades Hotel Co. is having plans prepared for the construction of a 7 story hotel including steam heating and refrigeration systems and 4 electric elevators on Ocean Ave. Estimated cost $1,100,000. E. J. Baurne, 124 San Vicente Blvd., is architect.

Conn., Bridgeport—Remington Typewriter Co., Railroad Ave., awarded contract for addition to factory including a power house to Stewart Engineering Co., 17 East 42nd St., New York, N. Y. Estimated cost $50,000.

Fla., Boca Raton—Ritz-Carlton Hotel Corporation, 42nd St. and Madison Ave., New York, N. Y., awarded contract for the construction of a hotel here to Dwight P. Robinson Co., Inc., 125 East 46th St., New York, N. Y. Estimated cost $4,000,000.

Ill., Chicago—Calumet Building Corporation, representing Calumet Council, Knights of Columbus, 6302 Cottage Grove Ave., is having plans prepared for the construction of a 14 story hotel and club at Stony Island Ave. and Marquette Road. Estimated cost $2,750,000. Hall, Lawrence, Ribbel & Ratcliffe, 123 West Madison St., are architects.

Ill., Chicago—McCormick Estate, J. F. Stone, Agt., 30 North La Salle St., will receive bids until Oct. 20 for the construction of a 6 story store building, including heating plant at Lake St. and Michigan Ave. Estimated cost $1,000,000. Holabird & Roche, 104 South Michigan Ave., are architects.

Ill., Chicago—South Park Comrs., E. J. Whitty, Secy., will receive bids until October 13, for the construction of a group of park buildings including boiler house, swimming pool, etc.

Ill., Cicero—S. J. Gregory, et al, c/o Levine & Rupert, 822 West 70th St., Chicago, Archts., will soon receive bids for the construction of a 3 story apartment and theatre building at 25th St. and 53rd Ave. Estimated cost $500,000.

Kan., Leavenworth—Abernathy Furniture Co., 1513 West 9th St., Kansas City, Mo., awarded contract for the construction of a 4 story plant including power house, etc., here, to J. G. Barnes. Machinery will be installed.

Kan., Wichita — Independent Ice & Cold Storage Co., 434 North Wichita St., plans the construction of a 60 x 100 ft. ice and cold storage plant at Central, Pacific and Missouri Sts. Private plans. Work to be done by company forces.

La., Shreveport—Texas & Pacific Railway Co., 1003 Texas & Pacific Bldg., Dallas, Tex., awarded contract for the construction of a round house, shops, power house, etc., here, to V. E. Ware, 1614 East Missouri St., El Paso, Tex. Estimated cost $200,000. E. F. Mitchell, is chief engineer.

Mass., Cambridge (Boston P. O.)—New England Confectionery Co., 253 Federal St., Boston, awarded contract for the construction of a group of buildings, including a power house, etc., at Massachusetts Ave. and Lansdowne St. here to Hegeman-Harris Co., 360 Madison Ave., New York, N. Y.

Mass., Lawrence—P. R. McNulty, Dir. of Engineering, will receive bids until Oct. 5th for furnishing and installing a 4,200 g.p.m. turbine driven centrifugal pumping unit, complete with auxiliaries, 1,400 g.p.m. motor driven centrifugal pumping unit, 175 hp. water tube boiler and equipment for waterworks pumping station. Morris Knowles, Inc., Westinghouse Bldg., Pittsburgh, Pa., is engineer.

Mass., Monroe—New England Power Co., 35 Harvard St., Worcester, is having preliminary plans prepared for the construction of a 9,000 kw. power station and 90 ft. dam on the Deerfield River here.

Mich., Holland—Sewage Comn., C. Kirchen, Chn., will receive bids until Oct. 21, for the construction of a sewage treatment plant including pumping station, electrically driven vertical centrifugal pumps, etc.

Minn., Bemidji—State Board of Administration, H. W. Austin, Chn., Capitol, St. Paul, plans the construction of a heating and power plant for State Teachers College here. Estimated cost $105,000. C. H. Johnston, 715 Capitol Bank Bldg., St. Paul, is architect.

N. J., Atlantic City—Chalfonte-Haddon Hall, North Carolina and Beach Sts., awarded contract for the construction of a power plant at Leeds and Lippincott Sts., to Irwin & Leighton, 126 North 12th St., Philadelphia, Pa. Estimated cost $250,000.

N. Y., Huntington—Board of Water Comrs., J. Schofield, Pres., at Huntington South Side Civic Assn. Bldg., New York Ave. and Melville Rd., will receive bids until Oct. 3 for the construction of a waterworks system, including pumping equipment, etc.

N. Y., New York—H. A. Blumenthal, c/o Schwartz & Gross, 347 5th Ave., Archts., is having plans prepared for the construction of a 9 story apartment on West 78th St. Estimated cost $500,000.

N. Y., New York—J. F. Faiella, 155 West 72nd St., plans the construction of a 16 story apartment at 1021 6th Ave. Estimated cost $1,000,000. Work will be done by separate contracts under the supervision of R. Candela, 200 West 72nd St., Archt.

N. Y., New York—W. W. Mills, Municipal Bldg., Comr. of Plants and Structures, will receive bids until October 2 for furnishing and installing electrical equipment for the central motor repair shop at 16th St. and Avenue C.

N. C., Charlotte — Southern Power Co., 432 South Church St., plans the construction of an 80,000 hp. emergency steam power plant on the Catawba River. W. S. Lee, 433 East Morehead St., is engineer.

N. C., Greensboro—W. H. Anderson Co. awarded contract for the construction of a cold storage plant to F. Mousser, 1025 South Garden St. Estimated cost $250,000.

O., Middletown — City, J. Kunz, Clk., plans the installation of an 18,000 gal. capacity pump for waterworks system. W. G. Morrison, City Hall, is engineer.

O., Toledo—Commodore Perry Hotel Co. awarded contract for the construction of a 17 story hotel on Jefferson Ave., to H. J. Spieker Co., Nashby Bldg. Estimated cost $2,500,000.

Okla., Apache — City plans an election October 7 to vote $60,000 bonds for the construction of a new waterworks system including 2 triplex pumps, motors, etc. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Okla., Bethany—City is having plans prepared for improvements to waterworks and sewage systems including pumping equipment, mains, etc. Estimated cost $55,000. H. E. Musson & Co., Grain Exchange Bldg., Oklahoma City, are engineers.

Okla., Enid — City voted $215,000 bonds for improvements to waterworks system including pumping equipment, mains, etc. R. T. Williams, is city clk.

Okla., Ponca City—Marland Oil Co., W. Marland, Pres., Lewis and Frisco R.R. tracks, Tulsa, plans the installation of 4 additional water tube boilers, 550 hp. each; also plans the construction of a new boiler plant, 30,000 gal. settling tank, etc. Estimated cost $250,000.

Okla., Tecumseh — City voted $15,000 bonds for extensions to waterworks system including a new motor driven triplex pump, etc. F. D. Brown, Shawnee, is engineer.

Okla., Tuttle — City voted $38,600 bonds for the construction of a new waterworks system including a deep well pump, motor, tank on tower, mains, etc. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Ore., Prosper—City will soon receive bids for the construction of a municipal waterworks system including 2 wells, pumping equipment, etc. Estimated cost $125,000.

Philadelphia—Mastbaum Bros. & Fleisher, 1424 South Penn Sq., will build a 6 story bank and office building at 1600-1602 Chestnut St., by day labor. Estimated cost $500,000. Hoffman-Henon Co., Finance Bldg., is architect.

Tenn., Chattanooga — Tennessee Electric Power Co., 540 Market St., plans to expend $1,200,000 in 1926 for improvements and extensions including steam plant at Dale's Bar and steam turbines at Nashville, etc. Estimated cost $300,000 and $500,000 respectively.

Tex., Archer City—Wichita Falls Electric Co., Wichita Falls, has acquired the municipal plant and plans improvements to increase capacity. Estimated cost $75,000. Company engineers in charge.

Tex., Brownsville — Owner, c/o H. S. Shaner, Engr., plans the construction of a 45 ton capacity ice and cold storage plant. Estimated cost $100,000.

Tex., Harlingen — Valley Electric & Ice Co. will soon award contract for the construction of a 30 ton ice plant. Estimated cost $65,000. J. M. Marriott, Frost Bldg., San Antonio, is engineer. Owner is in the market for equipment.

Tex., Hurlwood—M. G. Williams, et al, Lubbock, will soon receive bids for the construction of a cotton gin including a Diesel engine, etc., here. Estimated cost $35,000.

Tex., Luling—United North & South Oil Co. will electrify its entire oil field operations. Plans include the construction of a 3,000 hp. power plant. Estimated cost $500,000. Company engineers in charge. Machinery will be purchased.

Tex., Palestine — Palestine Ice Co. awarded contract for the reconstruction of ice plant to increase capacity 20 ton daily to Ophuls & Hill, Inc., 112 West 42nd St., New York, N. Y. Estimated cost $45,000.

Tex., San Antonio—San Antonio Ice Rink Co., c/o J. K. Tobin, et al., awarded contract for the construction of a refrigerating plant for ice skating rink on Myrtle St., to Triumph Ice Machine Co., South St., Oakley, Cincinnati, O. $40,000.

Wash., Auburn—Town has received permit from State Superior of Hydraulics, to appropriate 15 ft. of water from Coal Creek Springs to be used as a municipal water supply and to develop hydro-electric energy. Estimated cost $200,000.

Wash., Olympia—The Lilliwaup Power & Light Co., 206 First Ave. South, Seattle, plans a 2,000 hp. power development including dam, etc., on Hood Canal at Lilliwaup Falls. Estimated cost $200,000.

Wis., Browntown—Merrell-Soule Co. will build a 2 story factory. Estimated cost $150,000. Refrigeration machinery and three 450 hp. tubular boilers, etc., will be required.

Wis., Milwaukee — Central Bd. of Purchases, will receive bids Sept. 28 for 3 stokers, 2 vacuum pumps and one feed water heater.

Wis., Milwaukee—Fiebrantz Commission Co., 370 State St., awarded contract for construction of a cold storage plant to Jahns & Knuth Co., 1915 Chestnut St. Estimated cost $40,000.

Ont., Campbellford — Quinte & Trent Valley Power Co., subsidiary of Canadian Paperboard Co., awarded contract for the construction of a 1,000 hp. vertical unit hydro-electric plant to J. J. McNab, Trenton. Also awarded contracts for 900 kva. generator to Swedish General Electric Co., 107 Duke St., Toronto and 1,000 hp. turbine to William Hamilton Co., Ltd., Peterborough. Estimated total cost $100,000. Kerry & Chace, Ltd., Confederation Life Bldg., Toronto, are engineers.

Ont., Fort William—City plans electrifying and improving the Mount McKay and Kakabeka Falls railway. Estimated cost $28,000. C. B. Symmes, City Hall, is city engineer.

Ont., London—Lynch Construction Co., 100 East 42nd St., New York, N. Y., has had plans prepared for the construction of a 6 and 8 story hotel including steam heating system on Wellington St. here. Estimated cost $1,000,000. Private plans.

Ont., Oshawa—City plans the construction of a new pumping station including pumphouse, electric centrifugal 3 stage pumps, etc. Estimated cost $50,000. W. C. Smith, Municipal Bldg., is engineer.

Ont., Windsor—City plans extensions to filtration plant including pumps, etc. Estimated cost $150,000. M. E. Brian, City Hall, is engineer.